Agar medium 'A'

Ammonium nitrate	...	10 gms.
Calcium sulphate	...	5 gms.
Magnesium sulphate	...	1 gm.
Lactic acid	...	2 gms.
Agar	...	20 gms.
Water	...	1000 c.c.

Agar medium 'B'

Ammonium nitrate	...	10 gms.
Calcium sulphate	...	5 gms.
Magnesium sulphate	...	1 gm.
Glucose	...	20 gms.
Agar	...	20 gms.
Water	...	1000 c.c.

Pathogenicity of *P. aphanidermatum*, *R. solani* and *Fusarium* sp. was carried out in different lots of pots containing sterilized soil. The pots were divided into different sets. In one of the sets the culture of the fungus was mixed in the sterilized soil and the seeds were sown. In the second set the seeds were sown first in sterilized soil and then the suspension of spores was utilized for irrigating the pots. In the third set the seeds were thoroughly mixed with the fungus culture and then sown in sterilized soil. The fourth set was kept as control where the seeds were sown in sterilized soil. The percentage of damage was calculated.

The effectiveness of various fungicides, Agrosan GN (Phenyl mercury acetate), Ceresan (Ethyl mercury chloride), Spergon 96% chloranil (Tetrachloro para-benzo-quinone), Phygon (2, 3 dichloro 1, 4 naphthoquinone) Copper sulphate-solution, Formalin solution, Mercuric chloride solution, Copper carbonate and Zinc oxide in controlling the disease was studied.

Seed treatment :

The seeds were thoroughly treated with the fungicides and sown in four different sets of pots. The first set had naturally infested soil, the second was inoculated by *P. aphanidermatum*, third by *R. solani* and fourth was inoculated with a mixture of *P. aphanidermatum* and *R. solani*. These sets were replicated three times. The percentage of pre- and post emergence damping off was taken and their data was also statistically analysed.

RESULTS

Cultural characters :

The growth of *P. aphanidermatum*, *R. solani* and *Fusarium* sp. was quite rapid in potato-dextrose, 'A' and 'B' media. The sclerotia of *R. solani* were formed in abundance (Plate II, A. & B.)

Pathogenicity studies :

Seventy-eight, 57 and 25 per cent of seedlings were damped off by *P. aphanidermatum*, *R. solani* and *Fusarium* sp. respectively.

Plate I. Showing symptoms of damping off disease of chilli-seedlings.

Plate II-A. Growth on 2% Potato-dextrose agar.

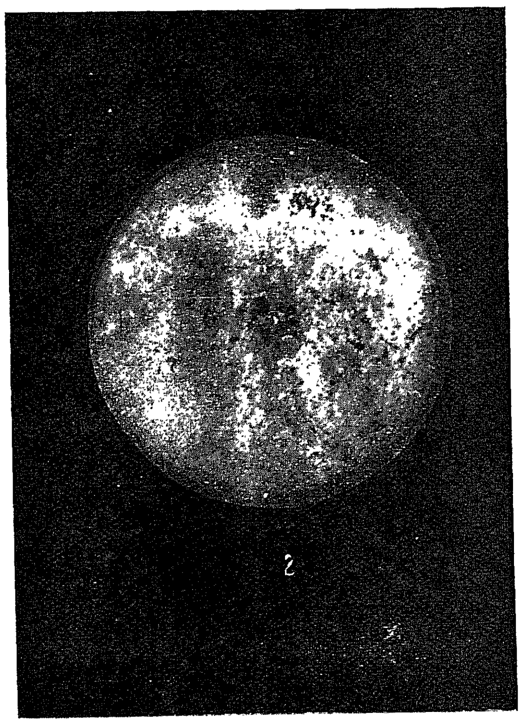

Plate II-B. Growth on chilli-seedlings agar.

The isolations from the diseased seedlings gave *Pythium aphanidermatum* (Edson.) Fitz. and *Rhizoctonia solani* Kühn which agreed with the general description of the two types. (Butler, 1907) & (Shaw, 1912).

SEED TREATMENT

TABLE I

Showing Pre-emergence damping off

S. No.	Treatments	Percentage of pre-emergence damping off
1.	Control	33·5
2.	Ceresan	3·8
3.	Agrosan GN	5·2
4.	Copper carbonate	6·8
5.	Zinc oxide	7·6
6.	Mercuric chloride	8·9
7.	Copper sulphate	9·5
8.	Spergon	9·8
9.	Formaline	10·1
10.	Phygon	10·7

The symbolic representation of the average percentage of damped off seedlings placed in order is as follows :

Ceresan	Agrosan GN.	Copper carbonate	Zinc oxide	Mercuric chloride	Copper sulphate	Spergon	Formalin	Phygon	Control	Standard error	Critical difference
3·8 >	5·2 >	6·8 >	7·6 >	8·9 >	9·5 >	9·8 >	10·1 >	10·7 >	33·5	0·14	0·392

The above representation shows that Ceresan is the best fungicide for controlling pre-emergence damping off next comes Agrosan GN which is less efficacious in controlling the disease than Ceresan and is closely followed by copper carbonate. Each and every fungicide is effective for reducing the disease percentage as compared to control.

TABLE II

Showing Post-emergence damping off

S. No.	Treatments	Percentage of Post-emergence damping off
1.	Control	55·5
2.	Agrosan GN	21·5
3.	Zinc oxide	23·9
4.	Ceresan	24·3
5.	Mercuric chloride	26·4
6.	Copper carbonate	28·3
7.	Copper sulphate	30·8
8.	Phygon	31·8
9.	Spergon	32·6
10·	Formalin	34·0

The Symbolic representation of the fungicides in controlling Post-emergence percentage of damping off seedlings placed in order is as follows :—

Agrosan GN.	Zinc oxide	Ceresan	Mercuric chloride	Copper carbonate	Copper sulphate	Phygon	Spergon	Formalin	Control	Standard error	Critical difference at 5%
21·5 >	23·9 >	24·3 >	26·4 >	28 3 >	30·0 >	31·8 >	32·6 >	34·07 >	55·5	0·086	0·[illegible]35

It is clear from the above representation that Agrosan GN and Zinc oxide lessened the post-emergence damping off against Ceresan and Mercuric chloride. Since Agrosan GN is the best in controlling pre- and post-emergence losses as compared with other fungicides.

SUMMARY

Damping off of chilli-seedlings is a serious problem of nursery growers in Uttar Pradesh. Three fungi were isolated from the damped off seedlings.

The isolates have been described and identified as *Pythium aphanidermatum* (Edson). Fitz., *Rhizoctonia solani* Kühn, and *Fusarium* sp. On the basis of their cultural and morphological characters. All the three fungi were found to be pathogenic.

Out of the several fungicides tried as seed treatments Ceresan is the most efficacious dry seed protectant in controlling pre-emergence damping off and Agrosan GN is the best fungicide in controlling post-emergence damping off.

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THE FREE AMINO ACID CONSTITUENTS OF THE ADULT (PINK) DESERT LOCUST, *SCHISTOCERCA GREGARIA* FORSK.

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INTRODUCTION

Schistocerca gregaria Forsk., commonly known as desest locust, is destructive and very serious pest of all crops. Studies on the nutritional physiology of the adult locusts with particular reference to amino acids and proteins were undertaken in the sectional laboratory employing descending single as well as two dimensional paper chromatographic technique.

MATERIAL AND METHOD

The culture of the desert locust was maintained in the sectional insectary in rearing cages. At each time a pink adult of the locust was taken from the culture and its alimentary canal was dissected out and removed. The insect was then macerated with a mortar and pestle in sufficient absolute ethanol so that the final concentration of the alcohal became about 80% by volume. The insoluble material was removed by filteration and washed several times with 80% ethanol. The filterate thus obtained was taken in a separating funnel and three volumes of chloroform was added to it. After thorough mixing through constant shaking, the mixture was allowed to stay for sometime and the resultant upper aqueous layer was removed and concentrated.

With this material spots were put on Whatman No. I filter paper by means of finely drawn glass jets and then dried by a hair drier and this operation was repeated as many times as was required to obtain a good concentration of the material on the paper. The spotted paper was allowed to saturate for 24 hours in chromatographic chamber containing the solvent mixture. The solvent used for unidimensional chromatography was 40 : 10 : 50 Butanol-Acetic acid-Water and for two dimensional chromatography water saturated buffered phenol was used as second solvent. After saturation, the filter paper was put inside the trough containing the solvent with the reference line of the paper on the upper side and the solvent allowed to flow down through the spots. When the flow of the solvent was obtained to the desired length of the paper, the paper was taken out and dried in the air at room temperature.

0·2% solution of Ninhydrin (Triketohydrindene hydrate) in water saturated normal butanol was finely sprayed through an atomizer over the chromatogram for colour development. The colour was developed by placing the chromatogram in a mechanical convention oven at 60°C for exactly fifteen minutes.

The different amino-acids were first roughly identified after comparasion of the two dimensional chromatograms. The rough identifications were confirmed by superimposition technique in the unidimensional chromatograms.

SUMMARY OF RESULTS

Through the superimposition technique of known amino acid with the material for analysis consisting of a number of unknown amino-acids it has been determined that the adult (Pink) of desert locust consists in all 12 free amino-acids. Of these nine were identified as (1) Lysine (2) Serine (3) Glycine (4) Glutamic acid (5) Threonine (6) α Alanine (7) Proline (8) Methionine or/and Valine (9) Leucine.

CONCLUSION

With the application of descending chromatography and superimposition technique 12 different amino acids were separated and 9 of them were identified. Further work is in progress to determine the identity of the three remaining free amino acids found present in the adult (Pink) of the desert locust.

CHROMOSOME STUDIES IN THE DIGENETIC TREMATODES OF THE FAMILY PARAMPHISTOMATIDAE

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INTRODUCTION

Although considerable attention has been given to the life cycle and the germ cell cycle in the digenetic trematodes, the study of the chromosomes is only incidental in this group. Britt (1947) described the number and behaviour of the Chromosomes in 34 species representing 8 families and reviewed the already available literature on chromosome numbers in 10 other families of the digenetic trematodes. Further information regarding the chromosome numbers in digenetic trematodes is added by Willmott (1950), Willey *et al.* (1950–51), John (1953), Pieper (1953), Sanderson (1953), Van der Woude (1954), Dhingra (1954–55), Woodhead (1955), Ciordia (1956), Guilford (1955, 1958), Nez and Short (1957), Short (1957), Gresson (1958) and Walton (1959).

The present paper deals with the studies of the spermatogenesis and the chromosome morphology in the adult *Diplodiscus amphichrus magnus* Shrivastava, 1934, of the family paramphistomatidae. Chromosome numbers of seven species of this family, which are already known, have also been reviewed here.

MATERIAL AND METHOD

The adult parasites were collected from the rectum of the frogs and immediately put into Carnoy's fixative. Acetorcein or Acetocarmine squash preparations of the testes gave satisfactory results for chromosome studies. For sections material was fixed in Bouins for twelve hours or in Carnoy's fixative for two hours. The sections were cut 10 μ in thickness and stained in iron haematoxylin or in crystal violet.

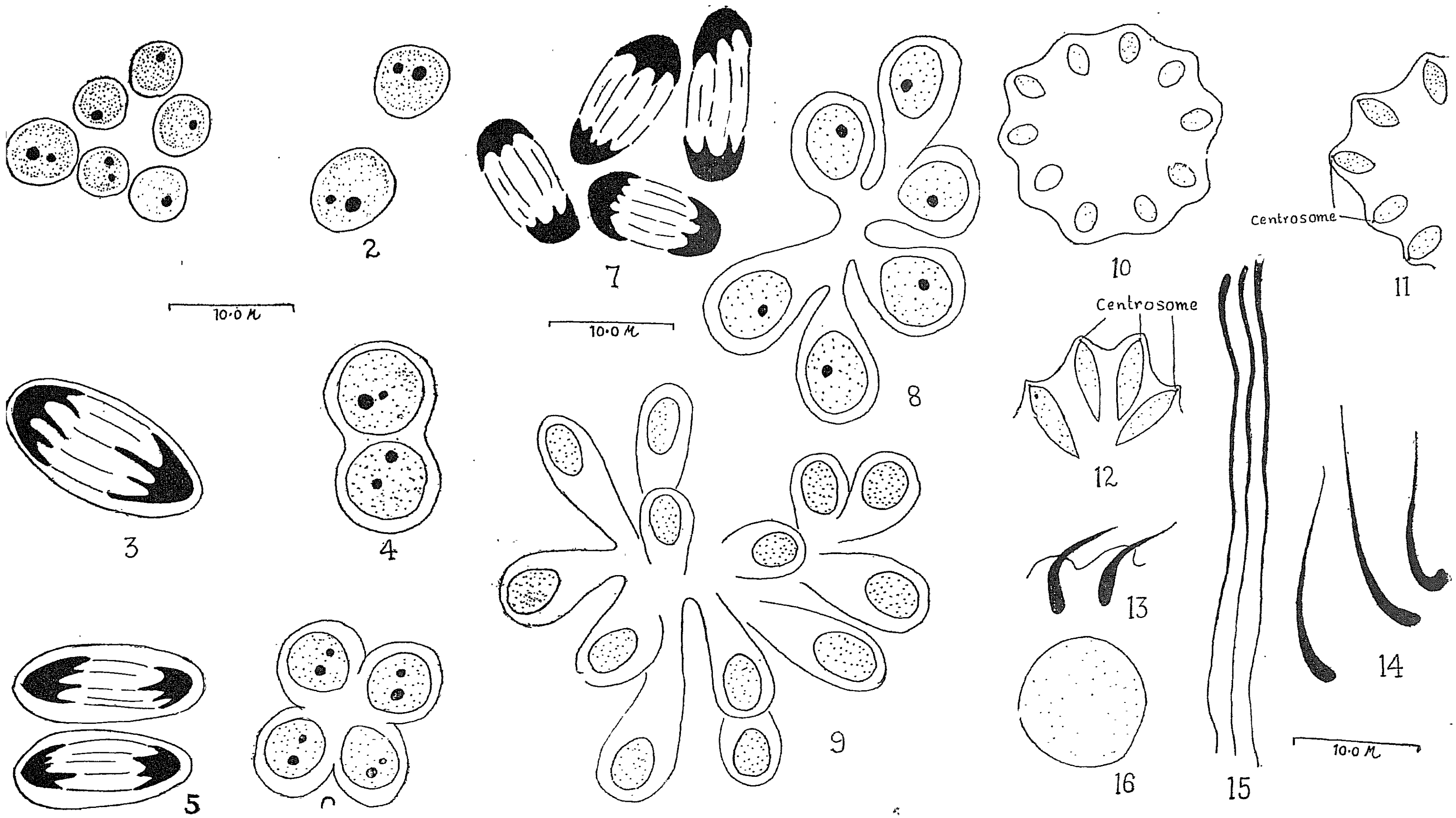
All the drawings were made with the aid of Camera lucida and then enlarged.

Diplodiscus amphichrus magnus :

The wall of the testis is rather thick and is formed of fibrous tissue. The germ cells lie free in the testis and they do not show distinct orientation. The primordial germ cells and the spermatogonia often lie near the testis wall and the spermatocytes and the spermatids are more central in position.

SPERMATOGONIA

The primordial germ cells are found in patches in the peripheral region of the testis. The cellular outlines of these cells are rather indistinct and they measure 4–6 μ in diameter. They possess one or two nucleoli each (Fig. 1). Primordial germ cells undergo mitotic divisions. They grow and enter into primary spermatogonial stage. The primary spermatogonia measure about 6-8 μ in diameter. Their nuclei contain one or two nucleoli each. (Fig. 2). They divide into two secondary spermatogonia which remain associated together (Fig. 3, 4).


2
7
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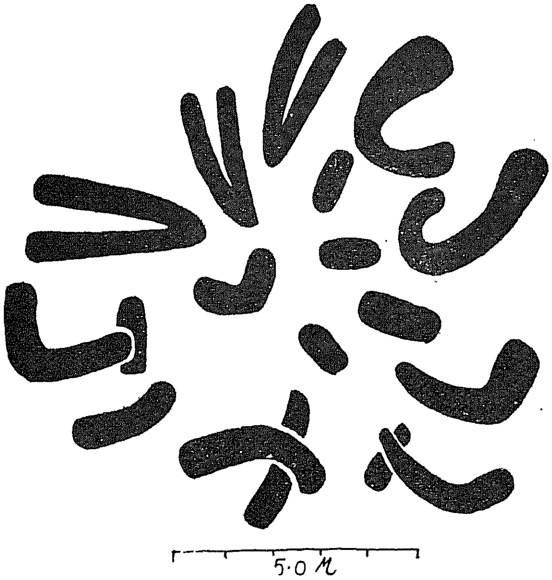

Fig.17

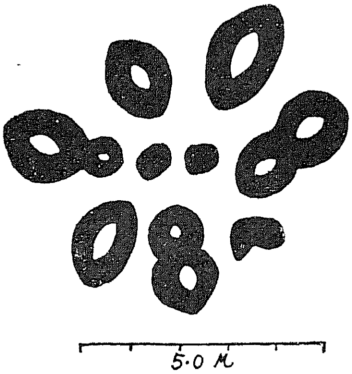

Fig.18

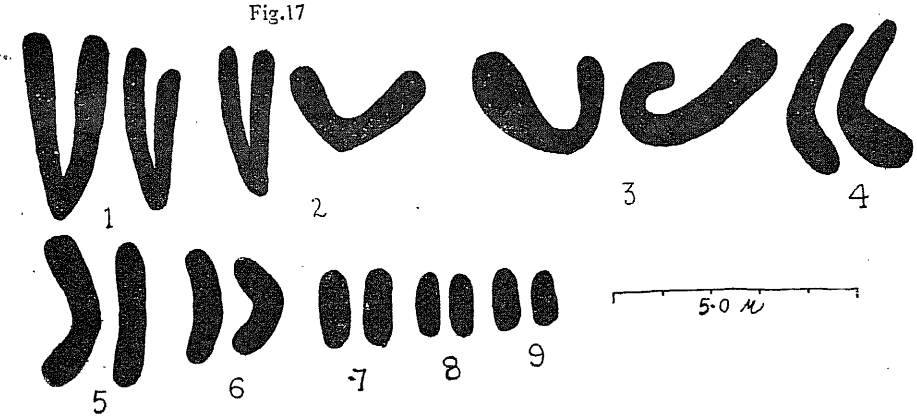

Fig. 19

EXPLANATION OF FIGURES

Fig. 1. A group of primordial germcells. Bouin's and Iron Haematoxylin.
Fig. 2. Full grown primary spermatogonium, showing two nucleoli, Bouin's and Iron Haematoxylin.
Fig. 3. Primary spermatogonium at late telophase. Acetorcein squash.
Fig. 4. Secondary spermatogonia invested in a common cytoplasmic sheath. Acetorcein squash.
Fig. 5. Secondary spermatogonia in telophase. Bouin's and Iron Haematoxylin.
Fig. 6. Tertiary spermatogonia, occuring in a group of four, each having two nucleoli. Bouin's and Iron Haematoxylin.
Fig. 7. Tertiary spermatogonia in telophase. Acetorcein squash.
Fig. 8. Six out of eight primary spermatocytes in a cluster. Acetorcein squash.
Fig. 9 Thirteen of the sixteen secondary spermatocytes, centrally connected. Acetorcein squash.
Fig. 10. Ten of the 32 spermatids. Bouin's and Iron Haematoxylin.
Fig. 11. A part of the spermatid clu ter, showing the nuclei ovoid in form. Bouin's and Iron Haematoxylin.
Fig. 12. Developing spermatids, showing the nuclei elongated and a centrosomal granule at the base of each spermatid nucleus. Bouin's and Iron Haematoxylin.
Fig. 13 Developing spermatids, showing the nuclei turned basophilic. Bouin's and Irom Haematoxylin.
Fig. 14. Developing spermatids flagellate form. Acetorcein squash.
Fig. 15. Mature sperm. Acetorcein squash.
Fig. 16. Residual cytoplasmic mass.
Fig. 17. Mitotic metaphase plate of primary spermatogonium. Acetorcein squash.
Fig. 18. Diplotene stage. Acetorcein squash.
Fig. 19. Karyogram—9 homologous pairs of chromosomes in order of their size.

The secondary spermatogonia attain the diameter of 8–9 μ. They contain two nucleoli each. The two associated secondary spermatogonia undergo mitosis simultaneously and divide into four tertiary spermatogonia (Fig. 5, 6).

The four tertiary spermatogonia remain connected together by the cytoplasmic strands (Fig. 6). They measure about 7 μ in diameter. The nucleus in each is seen to have two nucleoli. As the division of the four tertiary spermatogonia is simultaneous, the metaphase chromosomes of all the four tertiary spermatogonia can be clearly seen.

SPERMATOCYTES

The tertiary spermatogonia on division result in the formation of a cluster of eight cells which grow to form the primary spermatocytes (Fig. 7, 8). Each primary spermatocyte measures 7–9 μ in diameter. They divide twice to give rise to spermatids.

In a few preparations diplotene configurations were found and the number of chiasmata could be counted for each bivalent. In is seen that 108 bivalents show 221 chiasmata Therefore the chiasma frequency in this species is 2·04 per bivalent at diplotene stage. It is observed that the biggest bivalent of a set has invariably three chiasmata, while the rest have generally two chiasmata (three in some cases) each. The divisions of the primary spermatocyte cluster leads to the formation of a cluster of 16 secondary spermatocytes. In the young secondary spermatocytes the nuclei are lightly stained and they do not show nucleoli in them. Each measures 6–7 μ in diameter (Fig. 9). The second meiotic division produces a cluster of 32 spermatids which lie in a common cytoplasmic mass (Fig. 10).

SPERMATELEOSIS

The spermatids are weakly stained and show no nucleoli in them. The first nuclear change in the spermatids involves the condensation of the chromatin mass. The nuclei become ovoid and they come to lie close to the cell wall towards the outer free boundaries of the spermatids. A centrosome granule is seen between the nucleus and the cell membrane (Fig. 11, 12). The nuclei then become elongated. They show less affinity for the basic dyes but later with elongation of the nuclei, the basiphilic tendency is increased and ultimately the nuclei become threadlike and stain intensely (Fig. 13, 14, 15).

The ripe sperms come out leaving the residual body of the cytoplasm which has the diameter of 11–12 μ (Fig. 16). The spermatozoon measures 50–55 μ in length. There is no marked differentiation between the head and the tail, the anterior portion gradually tapers to a tail (Fig. 15).

CHROMOSOMES

The mitotic chromosomes were studied from the metaphase plates of the spermatogonia, while the meiotic chromosomes were studied from the metaphase plates of the primary and the secondary spermatocytes. The haploid number of the chromosomes is nine and the diploid number is eighteen for this species (Fig. 17, 18, 19).

It is seen that the chromosomes of *Diplodiscus amphichrus magnus* fall into three distinct groups. There are three pairs of large chromosomes, 6·5—3·5 μ in length ; three pairs of medium size chromosomes 2·5—3·5 μ in length and the three small pairs of about 1—1·5 μ in length. Further critical analysis gives the following results :—

(1) The first and the second pairs of large chromosomes are V-shaped with equal arms and median centromeres.

(2) The third pair of large chromosomes and the fourth and the fifth pairs of chromosomes of medium size have unequal arms and submedian centromeres.

(3) The sixth pair is metacentic with equal arms.

(4) The rest of the chromosomes are small and rod-shaped.

Chromosome studies in other species of the family paramphistomatidae :

Gigantocotyle bathycotyle :

Willmott (1950) described the gametogenesis and early development in *G. bathycotyle*. The chromosome counts were made at diakinesis and metaphase of meiosis. The diploid number of chromosomes of this species reported is twelve, the complement being made up of eight short and four long chromosomes.

Paramphistomum hiberniae and *P. Scotiae*

As reported by Willmott (1950), the haploid number of chromosomes in *P. hiberniae* is 6–8 and in *P. scotiae* is 8. The account of chromosomes in these two species is incomplete.

Zygocotyle lunata :

Willey *et al.* (1951) studied gametogenesis, fertilisation and cleavage in *Z. lunata*. As reported by them, in the first cleavage there are two pairs of acrocentric chromosomes about 5·5 μ long ; two pairs between 4·0 and 4·5 μ long, one of which is acrocentric and the other metacentric ; two pairs of acrocentric between 3·0 and 3·5 μ long ; and one pair of small metacentric chromosomes, about 3·0 μ in length. The chromosomes identified in dividing intestinal and subcuticular cells and in the primary spermatogonia were reported shorter by about 0·5 μ to 1·0 μ than those seen in early cleavage stages. The diploid chromosome number is fourteen and hapoid number is seven.

Megalodiscus temperatus (=Diplodiscus temperatus) :

Van Der Woude (1954) reported the diploid chromosome number in this species as eighteen and haploid as nine. From her camera lucida sketches of early cleavage stages, the following impression of the form of chromosomes is presumed. The longest pair is J–shaped. The second and third pairs are also equally long and V-shaped. The fourth pair is loop-like, like a figure of 8 open on one side. The fifth, the sixth, the seventh, and the eighth pairs are rod like of varying length. The nineth pair is the smallest and rod like.

The reports on chromosome number of *D. temperatus* Stafford, 1905, by Cary (1909) are not valid as Cort (1915) showed that Cary in his life cycle studies was not dealing with *D. temperatus*, but had described two different species of larval trematodes. Cort described them from Cary's material as *Cercaria caryi* and *C. megalura.*

Cotylophoron elongatum :

Dhingra (1955) gave an account of spermatogenesis in *C. elongatum*. The mitotic chromosomes were studied from metaphase plates of primary, secondary, and tertiary spermatogonia, while the meiotic chromosomes were studied from metaphase plates of primary and secondary spermatocytes. Haploid number of

chromosomes reported is eight and the diploid sixteen. According to his descriptions the longest pair of chromosomes is 3 μ. The second pair is 2·5 μ long. The third pair is J-shaped with a submedian constriction and measures 2 μ. The fourth and the fifth pairs are respectively 1·75 and 1·5 μ in length. The rest of the three pairs are quite small and measure each from 1·0 μ to 1·25 μ in length.

Gastrothylax crumenifer :

Dhingra (1955) reported seven haploid and fourteen diploid chromosomes in *G. crumenifer*. According to his descriptions the longest pair, J-shaped, is 4·5 μ in length. The second pair, V-shaped, is 4 μ in length. The third pair has a median constriction, and measures 3·5 μ. The fourth pair is slightly curved, measuring 3·5 μ. The rest of the chromosomes are rod like, measuring 1 to 2 μ in length.

DISCUSSION

The sequence of stages in spermatogenesis of *D. amphichrus magnus* is essentially similar to that of other forms of this family so far described. Degenerating spermatogonia were not observed in this species. It is observed that a centrosome is incorporated during the formation of the sperm. In this respect the author agrees with the findings of Dhingra (1954–55) that "the sperm consists of a nucleus, a centrosome and a flagellum, the entire cytoplasmic mass having been cast off". Anderson (1935), Rees (1939), Markell (1943), and Willmott (1950) have regarded the sperm as a purely nuclear product.

In *Megalodiscus tempeiatus* and *D. amphichrus magnus* the chromosome number is eighteen. The morphology of the chromosomes shows much similarity in these two species. Comparing the first four pairs of chromosomes in the above species we find that in *D. amphichrus magnus*, the first two pairs are metacentric and the third and the fourth pairs are submetacentric (J-shaped) ; while in *M. temperatus* the first pair is submetacentric and the rest are metacentric.

Gigantocotyle bathycotyle and *Cotylophoron elongatum* are genetically distinct having the diploid chromosome number as 12 and 16 respectively.

Zygocotyle lunata and *Gastrothylax crumenifer* have the same diploid number (14). But there are district morphological differentiations in the chromosomes. Comparing the first four pairs of chromosomes we find that in *Z. lunata* the first, the second and the third pairs are acrocentric, J-shaped, while the fourth is metacentric ; and in *G. crumenifer* the first pair is acrocentric, J-shaped, the second and the third pairs are metacentric, V-shaped and the fourth is rod-shaped. The discriptions of *P. hiberniae* and *P. scotiae* are incomplete and hence they are excluded from the discussion.

SUMMARY

(1) The process of spermatogenesis in *Diplodiscus amphichrus magnus* has been described. The haploid number of chromosomes is nine and the diploid number is eighteen for this species.

(2) The chromosomes in other species of the family Paramphistomatidae are reviewed.

(3) The chiasma frequency in this species is 2·04 per bivalent at diplotene stage. The biggest bivalent has invariably three chiasmata formations.

(4) A centrosome granule is incorporated in the sperm during its formation.

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STUDIES IN METIOTIC BEHAVIOUR OF RUSK—AN INTERGENERIC HYBRID BETWEEN *CITRUS* AND *PONCIRUS*

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INTRODUCTION

Rusk is a hybrid between sweet orange (*Citrus sinensis*) and trifoliate orange (*Poncirus trifoliate*). The cross was made by Swingle and Webber in 1893 having sweet orange as the seed parent (Webber, 1948).

The tree is similar in shape to trifoliate orange. It is vigorous, hardy evergreen, tall and shapely with dense foliage. The leaves are trifoliate and larger than those of trifoliate orange.

MATERIAL AND METHOD

The material was collected from the plants growing in Naini Agricultural Institute. The anthers were fixed in a mixture of three parts absolute alcohal and one part acetic acid saturated with ferric oxide. The material was kept for twenty four hours in this solution and then acetocarmine preparations were made in the usual way.

Meiosis :

The chromosome number of this intergeneric hybrid was found to be eighteen (Fig. 1) which is also the diploid number for genus *Citrus*.

The chromosomes at early prophase are very thin and slender. In the cases observed one or two chiasmata are present in each bivalent (Fig. 1). The chiasmata are usually terminal but in few cases interstetial also. Univalents have been observed at diplotene which seem to result due to lack of synapsis (Fig. 2).

The chromosomes are further condensed and are well scattered inside the nuclear membrane thus entering diakinesis.

As metaphase I sets in the nuclear membrane disappears and all the bivalents are regularly oriented on the equator of the spindle (Fig. 4). No stray bivalent has been observed in any case. The number of univalents vary from two to eight (Figs. 5, 6, 7). These univalents occupy various positions inside the PMCs.

The Table I gives the types of configurations observed at metaphase I in 50 PMCs.

The chiasma frequency per bivalent is 1·11.

The bivalents disjoin regularly to the poles (Fig. 8). The spindle functions normally and it does not break down till the daughter bivalents have reached the poles. The univalents may get included in any pole by chance of their position.

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The univalents that form laggards do not divide at this stage (Fig. 9). Out of 158 cases observed 144 were normal while 14 showed laggards. By the study of further stages it becomes evident that these laggards are left in the cytoplasm when the chromosomes of the two telophasic plates relapse into resting nuclei.

TABLE 1

Types of configurations	No. of PMCs.
9_{II}	35
8_{II} 2_{I}	8
7_{II} 4_{I}	3
6_{II} 6_{I}	3
5_{II} 8_{I}	1
Total	50

After interkinesis two spindles are formed. The number of chromosomes oriented on these spindles may vary due to irregular separation and presence of laggards in the first division. The laggards of the first division could be observed as stray chromosomes lying in the cytoplasm (Fig. 10). The second division metaphase spindles function normally. The second anaphase is again marked by presence of stray chromosomes (Fig. 11). These stray chromosomes are ultimately lost in the cytoplasm as no micronuclei have been observed.

The pollen sterility is 52%.

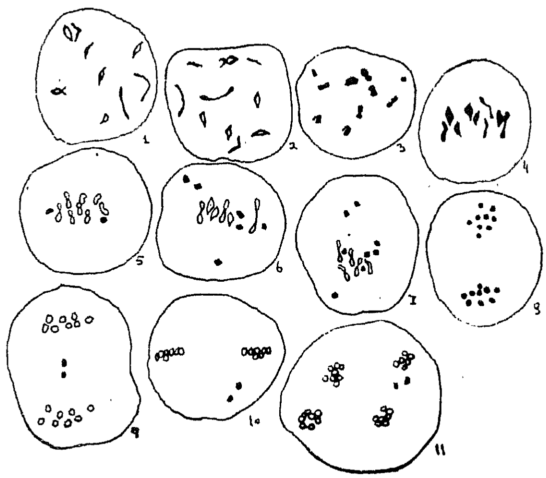

Fig. 1. Diplotene showing nine bivalents.
Fig. 2. Diplotene showing two univalents.
Fig. 3. Diakinesis showing two univalents.
Fig. 4. Metaphase I.
Fig. 5. Metaphase I showing two univalents.
Fig. 6. Metaphase I showing six univalents.
Fig. 7. Metaphase I showing eight univalents.
Fig. 8. Anaphase I.
Fig. 9. Anaphase I showing two laggards.
Fig. 10. Metaphase II showing two stray chromosomes.
Fig. 11. Anaphase II showing laggards. ×1162.

Inter-relationship between genera *Citrus* and *Poncirus* :

According to Swingle (1948) these two genera *Citrus* and *Poncirus* come under subtribe Citrineae, tribe Citreae of the subfamily Aurantoideae. In the subtribe Citrineae are included six genera with highly organised pulp vesicles. These genera are *Fortunella*, *Eremocitrus*, *Poncirus*, *Clymenia*, *Microcitrus* and *Citrus*. The genus *Poncirus* differs from these in having trifoliate leaves. In presence of oil droplets *Poncirus* is more closely related to subgenus Papeda of *Citrus* than Eucitrus, which has comparatively very few oil droplets. *Poncirus* is further related to *Citrus* in having pleimerous ovaries with 6–8 locules and with as many ovules in each locule.

The artificial hybrids involving *Citrus*, *Poncirus* and *Fortunella* have been obtained by Swingle and Webber. Swingle (1948) observed a natural occuring citrange, a hybrid between *Citrus* and *Poncirus* in Japan. This shows that inter-sterility isolating mechanism between these two genera has not developed completely.

The close relationship of chromosome complements of *Citrus* and *Poncirus* becomes clear when we study the pairing of chromosomes in their intergeneric hybrids.

It is really interesting that fairly regular pairing of chromosomes has been observed in Rusk, an intergeneric hybrid between *Citrus* and *Poncirus*. Though most of the chiasmata at diplotene are terminal yet interstitial chiasmata have also been observed. The chiasma frequency per bivalent is 1·11. No doubt this chiasma frequency is lower as compared to rest of the taxa of *Citrus* studied by the authors (Naithani and Raghuvanshi 1962 *a*, 1962 *b*), nevertheless, it approaches fairly near the chiasma frequency observed in Karna lemon, Rangpur lime, Sweet lime and Kagzi kalan lemon.

The average of univalents per PMC in Rusk is 1·08 while a comparatively much higher percentage (1·52 per PMC) is shown by *Citrus karna* (Naithani and Raghuvanshi 1962 *b*), which is suspected to be an interageneric hybrid of *Citrus*. Both Kagzi kalan lemon and marsh grapefruit show 1·2 and 1·12 univalents per cell (Naithani and Raghuvanshi 1962 *a*, 1962 *b*) which is again higher than what has been observed in Rusk. The maximum number of univalents observed at metaphase I in any PMC in Rusk is eight. *C. karna* also shows eight univalents at metaphase in some cells while maximum number of six has been observed in Kagzi kalan lemon (Naithani and Raghuvanshi 1962 *a*, 1962 *b*).

No bridge—fragment configuration or multivalent formation has been observed.

The pollen sterility in Rusk is 52%. The maximum pollen sterility was observed in Marsh grapefruit (86%) (Naithani and Raghuvanshi (1962 *b*), which is seedless. *C. penvisculata*, *C. Assamensis* and Kagzi kalan lemon respectively show 45%, 45% and 48% sterile pollen (Naithani and Raghuvanshi 1958 *a*, 1958 *b*, 1962 *a*). The percentage of pollen sterility in these cases is again fairly near the Rusk.

The meiotic behaviour of Rusk throws light on the relationship of chromosome complements of *Citrus* and *Poncirus*. Out of fifty metaphase plates studied thirty five were perfectly normal showing nine bivalents. The chiasma frequency per bivalent is 1·11. The bivalents disjoin regularly and the spindle functions normally. The present studies lead to the conclusion that there exists close similarity between chromosome complements of *Citrus* and *Poncirus*. These findings also support Swingle's view that *Poncirus* represents an ancient off-shoot from true *Citrus* fruit trees.

SUMMARY

The chromosome number of Rusk, an intergeneric hybrid between *Citrus sinensis* and *Poncirus trifoliata* has been found to be 2n = 18. Fairly regular bivalent formation takes place during meiosis. The spindle also functions normally. The pairing of *Citrus* and *Poncirus* chromosomes shows close similarity in the chromosomes complements of these two genera.

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AN EXPERIMENTAL STUDY OF THANATOSIS IN CARAUSIUS MOROSUS (Br)

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INTRODUCTION

Thanatosis or death feigning is exhibited by a large number of insects specially the beetles (Holmes 1931, Saxena 1957*a*, 1958 and 1961). An insect assumes an immobile posture by tightly pressing its legs and antennae to the body during the state of thanatosis. This paper deals with an experimental study of death feigning in *Carausius morosus* (Br.)

MATERIAL AND METHOD

Carausius morosus belonged to the same generation were kept in muslin topped cages under controlled conditions. The experimental insects before the induction of thanatosis were left undisturbed for 24 hours in order to avoid the state of excitement caused due to handling them, which may even prevent them from responding to stimulus. Thanatosis was induced in all the experiments by exercising a pressure on the sides of the thorax by thumb and forefinger and the insects were kept in the rounded tin boxes covered by perforated lids in order to provide ventilations and to prevent their escaping after the termination of thanatosis. Due to a very long period of thanatosis as much as 5 to 6 hours it was not possible to keep on watching continuously till its termination. Hence the insects during thanatosis state were observed after every 10 minutes to note the termination time. Due to my absence in most cases at the time of termination, approximate termination times were calculated by averaging the time of my last visit before termination and first after termination. The duration of thanatosis which is expressed in minutes was calculated by deducting the inducing time from the approximate termination time.

For studying the effect of illumination the special, apparatus and the experimental method followed previously (Saxena 1957) were employed with the modifications that the insects were kept under beaker of 5 inches diameter. The apparatus was designed to prevent the heat of the bulb reaching the experimental insects.

A mercury discharge lamp was used as the source of ultra-violet light for studying its effect on the insects. The lamp was completely covering the circular hole of the box used for studying the effect of illumination. No water trough was used in this case as the mercury discharge lamp does not radiate much heat.

The durations of thanatosis in all the experiments were transformed by taking the square root of each value and the mean transformed periods of thanatosis were plotted on the graph. The square root transformation was used in order to make the distribution of data more nearly normal and so as to make the variance in any group of observations independent of the mean.

EXPERIMENTAL RESULTS AND DISCUSSION

1. A general study of thanatosis :

(*a*) *Induction of thanatosis* : Being very sensitive to mechanical stimuli *C. morosus* could very easily be thrown into thanatosis state. By pinching the legs, picking the insect up by its antennae, pressing the head, thorax and abdomen by thumb and forefinger and separating the antennae and forelegs from each other, they fall into the motionless state. Blowing of air over the insects not only fails to evoke thanatosis but rather helps in terminating it. In the present work a pressure on the sides of the thorax exercised by thumb and forefinger has been adopted as a method for bringing about the motionless state. Autothanatosis has also been observed among these insects.

(*b*) *Posture in thanatosis* : Attaining of thanatosis in *C. morosus* is rather slow. The antennae stretched forward and tighty folded to the head form a characterstic feature during death feigning but position of legs may vary in different individuals.

(*c*) *Termination of thanatosis* : Unlike certain insects such as Calandras (Saxena 1961) only a slow movement of the antennae and not followed by the right and left movement of the head as in the case of other insects is the indication of the termination of the motionless state. The movement of the antennae is followed by the movement of legs and the insect stands up ready to walk.

(*d*) *Death feigning at different ages* : Because these insects have a long life and of the difficulty in obtaining them, it was not possible to perform this experiment on a large scale : small batches of insects were used. Five insects nearly a fortnight old, five from 2 to 3 months old and five about 7 to 8 months old were allowed a period of 24 hours to condition on small branches of the plants kept in a small flask filled with water. Thanatosis was induced individually by pressing the sides of the thorax with thumb and forefinger. The insects were left in the state of thanatosis in small rounded tin boxes at room temperatures. Thereafter the insects were observed after every 10 minutes and an approximate period of death feigning was calculated.

The results (Table 1) reveal that different durations of thanatosis are shown by young and adult *C. morosus*. These periods are as low as 23 minutes for 15 days old insects against the normal duration of 303 minutes in mature adults. The period for 2–3 months old insects falls in between these limits, showing that as the individual ages a gradual approach to the normal value is observed. This is also true in case of *Calandras* and coccinellids (Saxena 1961).

(*e*) *Effect of continuous application of stimulus* : Owing to a very long period of thanatosis it was not possible to design this experiment in a fashion similar to those with other arthropods (Saxena 1957 and 1961) as continuous induction of thanatosis after the termination of the previous one would have been rather a troublesome experiment to carry out with these insects having a duration of about 6 hours. Hence it was thought to perform the experiment by inducing thanatosis successively after artificially terminating the previous one by some means. Blowing of the air by mouth over the insect whilst it was in thanatosis state, was investigated and found to be the most effective and easy way of terminating death feigning.

Five adults for the experiment were allowed to lead a natural life for 24 hours on the leaves in a cage. As mentioned above the second and successive attempts to induce thanatosis were made just after terminating the previous one by the

method described above. Three insects out of five failed to show thanatosis after 4 to 6 successive inductions. One stopped responding at the 9th attempt and a 5th one started showing incomplete thanatosis, in particular incomplete contractions of legs and antennae, on the 11th attempt whilst the 13th attempt completely failed to evoke this state.

After a number of inductions the insects were found to be in an excited state and on further attempts instead of lapsing into a state of thanatosis they tried to escape. After a number of further unsuccessful attempts, I found the insects were exuding some liquid and at this stage I released them. To my surprise just after release, I saw them walking about very quickly. Such rapid walking in an excited state is rarely observed. As suggested in a previous paper (Saxena 1957) this may be due to fatigue stage reached by the insects. Kozanshikov (1931) also observed it in *Lochmaea capreae* L.

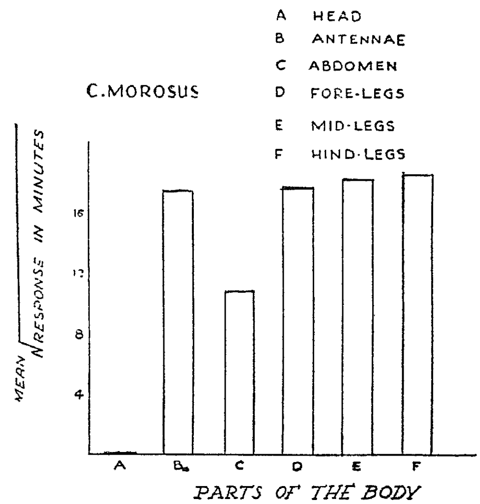

FIG. 1.

An experimental study of thanatosis in *Carausius morosus*

2. Effect of physical factors :

(*a*) *Effect on thanatosis of cutting off different parts of the body* : 30 insects of nearly the same age were divided into 6 batches of 5 each. Antennae, head, abdomen, forelegs, midlegs and hindlegs of the batches A, B, C, D, E, and F respectively were cut off. The mutilated insects were allowed to recover for 1½ hours individually on 18·5 cm. filter papers covered by round tin boxes with perforated lids. The induction and termination of thanatosis in the case of the insects whose abdomens were cut was observed by the movement of the antennae. Some of the experimental insects just after having the abdomen, antennae or legs cut off, went into the state of thanatosis. In such cases thanatosis was terminated artificially by blowing air on them, prior to recovery period. After the recovery period thanatosis was induced in each individual except those which were decapitated. After the induction of thanatosis the insects were observed after every 10 minutes and the duration of death feigning was calculated (Table 2).

TABLE 1

Response in Second

Insect	A	B	C	D	E	F
	About 15 days old					
	P	K	L	$\frac{k+L}{2}$	$\left(\frac{k+L}{2}-P\right)$	
	A.M.	A.M.	A.M.	A.M.		
1	10-30	10-40	10-50	10-45	15	3·87
2	,,	10-50	11-00	10-55	25	5·0
3	,,	11-00	11-10	11-05	35	5·91
4	,,	10-30	10-40	10-35	5	2·23
5	10-50	11-20	11-30	11-25	35	5·91
Mean					23	4·59
	2 – 3 months old					
	A.M.	P.M.	P.M.	P.M.		
1	10-35	12-15	12-25	12-20	105	10·24
2	,,	12-05	12-15	12-10	95	9·74
3	,,	12-15	12-25	12-20	105	10·24
4	,,	12-05	12-15	12-10	95	9·74
	A.M.	A.M.	A.M.	A.M.		
5	10-35	11-25	11-25	11-30	55	7·41
Mean					91	9·47
	7 – 8 months old					
	A.M.	P.M.	P.M.	P.M.		
1	10-40	3-50	4-0	3-55	315	17·75
2	,,	4-10	4-20	4-15	335	18·3
3	,,	3-30	3-40	3-35	295	17·18
4	,,	4-0	4-10	4-5	325	18·03
5	,,	2-40	2-50	2-45	245	15·65
Mean					303	17·33

A = Inducing time of thanatosis.
B = Time of last observation before thanatosis termination.
C = Time of first observation after thanatosis termination.
D = Approximate termination time of thanatosis.
E = Approximate duration of thanatosis.
F = Transformed period of thanatosis.

TABLE 2

Response in seconds after mutilating

HEAD A

No thanatosis was observed

ANTENNAE B

Insects	A1	B1	C1	D1	E1	F1
	P	K	L	$\frac{k+L}{2}$	$\left(\frac{k+L}{2}-P\right)$	
	A.M.	P.M.	P.M.	P.M.		
1	10-0	2-50	3-0	2-55	295	17·18
2	,,	2-20	2-30	2-25	265	16·28
3	,,	2-50	3-0	2-55	295	17·18
4	,,	3-10	3-20	3-15	315	17·75
5	,,	3-20	3-30	3-25	325	18·03
Mean					299	17·28

ABDOMEN C

	P.M.	P.M.	P.M.	P.M.		
1	3-30	5-30	5-40	5-35	125	11·18
2	,,	5-0	5-10	5-05	195	9·74
3	,,	5-30	5-40	5-35	125	11·18
4	,,	4-50	5-0	4-55	85	9·22
5	,,	5-40	5-50	5-45	135	11·62
Mean					113	10·59

FORE-LEGS D

	A.M.	P.M.	P.M.	P.M.		
1	10-0	3-0	3-10	3-05	305	17·47
2	,,	2-30	2-40	2-35	275	16·59
3	,,	3-40	3-50	3-45	345	18·58
4	,,	3-40	3-50	3-45	345	18·58
5	,,	2-30	2-40	2-35	275	16·59
Mean					309	17·56

contd.

MID-LEGS E

Insects	A1	B1	C1	D1	E1	F1
	P	K	L	$\frac{k+L}{2}$	$\left(\frac{k+L}{2}-P\right)$	
	A.M.	P.M.	P.M.	P.M.		
1	10-0	3-50	4-0	3·55	355	18·84
2	,,	3-0	3-10	3-05	305	17·74
3	,,	3·40	3-50	3-45	345	18·58
4	,,	3-10	3-20	3-15	315	17·75
5	,,	3·0	3·10	3·05	305	17·47
Mean					325	18·02

HIND-LEGS F

Insects	A1	B1	C1	D1	E1	F1
	A.M.	P.M.	P.M.	P.M.		
1	10-0	2·50	3-0	2-55	295	17·18
2	,,	2-50	3·0	2-55	295	17·18
3	,,	4-0	4-10	4-05	365	19·11
4	,,	4-40	4-50	4·45	405	20·13
5	,,	3-50	4·0	3-55	355	18·84
Mean					343	18·49

A1 = Inducing time of thanatosis.
B1 = Time of last observation before thanatosis termination.
C1 = Time of first observation after thanatosis termination.
D1 = Approximate termination time of thanatosis.
E1 = Approximate duration of thanatosis.
F1 = Transformed period of thanatosis.

TABLE 3

Analysis of variance of Table 2 (Abdomen)

	Degrees of freedom	Sum of Squares	Mean Square	Variance ratio
Treatment	1	115·3960	115·3960	104·98
Error	8	8·7952	1·0994	
Total	9	124·1912		

Variance ratio = 104·98 (Very significant).

The results (Fig. 1) show that the decapitated insects failed to show thanatosis whereas in the insects whose abdomen were cut it was possible to induce itfor a shorter period. Cutting of the legs and antenae did not affect their duration of death feigning. These results are in accordance with (Saxena 1961) and a similar conclusion may be drawn. The variance ratio calculated for the values obtained on mutilating the abdomen is highly significant (Table 3).

(*b*) *Effect of illuminations* : Thanatosis was induced in 5 adult insects after conditioning them in the dark, the insects being exposed during the experiment to light from 250 watt tungsten lamp. The insects covered by the beakers were left individually under the light and the time was noted. Hereafter the insects were observed after every 10 minutes to note the termination of thanatosis. Even after 8 hours duration no sign of termination was noticed. The light was then switched off and the insects were left in the dark. After spending nearly half an hour in the dark, one insect recovered from thanatosis and within about 1 hour thanatosis was terminated in all the insects. The results of this experiment point out the sensitivity of this particular species to light of low intensity and to the persistence of thanatosis under illumination. Another experiment was designed to confirm these results.

Five adult insects, after being conditioned in the dark for 24 hours, were put under the 250 watt lamp and covered by the beaker as already described. At this stage all the insects were normal and were walking up and down the walls of the beakers. After 15 minutes exposure to the light, thanatosis was observed, and within 30 minutes the posture of the insects was the same as that assumed after mechanical stimulation. The state of thanatosis was maintained for 3 hours after which time I switched the light off. Thanatosis of all the insects ended after nearly $1\frac{1}{2}$ hours of darkness. I then again tried to induce thanatosis by putting the light on but could succeed only with 2 insects. Finally after a recovery period of 12 hours in the dark thanatosis was again observed, under the same light intensity, in all the insects.

(*c*) *Effect of ultra-violet light* : Five adults were taken for the experiment and were placed while in normal condition, under the ultra-violet light. Within 5 to 10 minutes all of them went into a state of thanatosis, and continued in it for about 5 hours, at the end of which time I swithed the light off. After a further $1\frac{1}{2}$ hours in the dark all of them had come out of thanatosis.

The persistence of autothanatosis under ultra-violet points to the sensitivity of *Carausius morosus* to it. On the basis of this result, another experiment, similar to the one designed with ordinary light, was performed to confirm the sensitivity of *C. morosus* to ultra-violet light.

Five adults were conditioned for 24 hours in the dark and placed under the ultra-violet light. The insects were in normal condition and were walking up and down the walls of the box. After an exposure of 5 minutes to ultra-violet light one of them went into thanatosis, and within 25 minutes all the insects had gone into thanatosis, assuming the charactersitic posture assumed as the result of mechanical stimulation. This state continued for 1 hour, when I switched the light off. Termination of thanatosis did not occur until about $3\frac{1}{2}$ hours had been spent in darkness. Soon after termination, I again switched the light on, but no thanatosis was noticed. An attempt to induce thanatosis artificially at this stage also failed, except with one insect. After a recovery period of 12 hours, the insects again responded to ultra-violet light by showing thanatosis.

Holmes (1906) while working on Ranatra and Saxena (1958) while working on *A. vulgare* recorded a fall in the duration of thanatosis on exposure to light. But

C. morosus responded in a different fashion. This insect remains inactive in daylight and it remained in a state of thanatosis as long as was exposed to the artificial light including ultra-violet, thus showing its sensitivity to it. It came out of thanatosis soon after the light was switched off.

SUMMARY

Besides several others pressing the sides of the thorax by thumb and forefinger has been proved to be a sure method of inducing thanotosis in *Carausius morosus*. While in this state the insects assume a immobile posture with the antennae stretched forward and tightly folded to the head. The position of the legs may vary in individuals. The termination of thanatosis begin with the movement of antennae followed by the movement of the legs.

Different periods of thanatosis were recorded at different ages but after a certain age the normal duration is reached.

On continuous application of the stimulus the insect reaches a fatigue stage when it no more responds in the normal way. Decapitated insects fail to show thanatosis whereas it was possible to induce thanatosis in the insects whose abdomen were cut. No effect on thonatosis was recorded on cutting the legs and antennae.

C. morosus responds in a different fashion to the illumination. Thanatosis state is prolonged on keeping them under the light of different intensities. Ultraviolet light has a similar effect on them. Soon after switching the light off the termination of thanatosis was noticed.

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A NOTE ON PHOTOTROPIC RESPONSE OF INSECT PESTS TO DIFFERENT COLOURS OF LIGHT DURING DIFFERENT HOURS OF NIGHT

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INTRODUCTION

Amongst the various measures adopted for the control of insect pests, collection and destruction of some of the important species of these by attracting them on light-traps, is also of great importance in certain circumstances. The knowledge of the species and their stages which are very prone to be attracted to the light, the period during which they are most attracted and when they are found in abundance in the nature, is very essential for the successful adoption of this measure.

MATERIAL AND TECHNIQUE

It has been observed that the instinct of attraction in the insects towards certain colours of light, and during particular periods of nights, is very well developed. With a view to study these various aspects, a comprehensive programme was taken up during Kharif 1960 in the Sectional Insectary at Kanpur. Light-trap boxes having Milky, Blue, Green and Red Coloured glass-pan at the top were exposed from 7·00 P.M. to 12·00 P.M. and the names of the species, their number during particular hours and their preference of colour of light was noted. During the period from 5th August, 1960 to 7th September, 1960 a total number of 3146 insects were attracted on nine different dates, out of which 2486 insects were attracted on milky light, 452 on blue light, 192 on green light and only 16 on red light. The degree of attraction between the different colours of light being 79·05%, 14·35%, 6·10% and 0·50% in milky, blue, green and red lights respectively. The names of the species and their attraction on the different dates during different hours of the night are given in a tabular form.

CONCLUSION

It is evident from the above table that the milky light attracts the maximum number of insects, followed by blue, green and red. The red light attracts the least number. The number of species of these catches on the different coloured lights will definitely depend upon the type of crops being grown in a particular locality and the incidence and the intensity of attack of the insect pests infesting those crops.

Table I showing Phototropic Response of Insect Pests to different colours of light during different hours of night at the Sectional Insectary of Kanpur. Period of Observation—Kharif 1960—5th August to September, 1960.

TABLE

Sl. No.	Name of the insect pest	Colour of light on which attracted	Period of attraction	Number of Insect Pests attracted (datewise) 5/8/60	6/8/60	8/8/60	11/8/60	25/8/60	29/8/60	2/9/60	6/9/60	7/9/60	Total number attracted	Remarks
1.	Winged Termites	Milky	6–8 p.m.	76	60	26	4	–	–	–	–	–	166	
2.	Cotton Jassids, *Empoasca devastans* Dist.	Milky	7–11 p.m.	122	140	147	145	138	120	95	78	40	1025	
		Blue	7–9 p.m.	30	35	38	36	42	28	25	26	22	282	
		Green	7–9 p.m.	18	24	25	15	8	6	7	4	2	109	
		Red	8–9 p.m.	–	1	3	1	2	–	–	–	–	7	
3.	Paddy leaf hoppers, *Nephotettix* spp.	Milky	7–11 p.m.	115	138	149	142	130	115	92	70	24	975	
		Blue	7–9 p.m.	18	20	24	22	22	18	12	10	9	155	
		Green	7–9 p.m.	8	10	12	14	10	8	8	6	4	80	
		Red	8–9 p.m.	2	2	3	1	1	–	–	–	–	9	
4.	Castor Semilooper, *Achoea janata* Linn.	Milky	7–9 p.m.	1	–	2	1	–	–	2	–	–	6	
5.	Sunnhemp hairy caterpillar, *Utetheisa pulchella* Linn.	Milky	7–10 p.m.	6	8	12	15	12	10	6	5	4	78	
6.	Rice Gundhy bug, *Leptocorisa varicornis* Fab.	Milky	7–10 p.m.	18	20	24	16	12	10	7	6	2	115	
7.	Jasmine moth, *Glyphodes* spp.	Milky	8–9 p.m.	4	2	3	2	4	1	–	1	–	17	
		Blue	8–9 p.m.	–	1	–	1	–	–	–	–	–	2	
8.	*Aegocera venulia* Cram.	Milky	7–8 p.m.	3	1	4	2	–	–	2	–	–	12	
9.	Hairy caterpillar, *Amsacta* spp.	Milky	9–11 p.m.	–	3	–	–	1	1	–	–	–	5	

10.	Amaranthus caterpillar, *Hymenia fascialis* Cr.	Milky	9–11 p.m.	12	4	16	6	8	2	1	2	1	52
		Blue	9–10 p.m.	2	–	1	2	–	1	2	–	–	8
11.	Yellow blister beetle, *Gnathospastoides rouxi* C.	Milky	8–9 p.m.	–	2	–	3	–	1	–	2	–	8
		Green	8–9 p.m.	–	–	–	1	–	1	–	–	–	2
12.	Green blister beetle, *Lytta tenuicollis* P.	Milky	8–9 p.m.	–	–	2	–	–	–	–	–	–	2
13.	*Adoretus* spp.	Milky	10–11 p.m.	2	3	–	1	–	1	1	–	–	8
		Blue	8–9 p.m.	–	1	–	1	1	–	–	–	–	3
		Green	8–9 p.m.	–	–	–	1	–	–	–	–	–	1
14.	Kharif grasshopper, *Hieroglyphus* spp.	Milky	8–9 p.m.	–	–	1	–	2	–	–	–	2	5
15.	Fruit sucking moths, *Othreis* spp.	Milky	8–9 p.m.	–	–	–	1	–	–	1	–	–	2
16.	Rice butter-fly, *Melanitis ismene* Cr.	Milky	6–7 p.m.	–	–	–	–	–	1	–	–	1	2
17.	Cotton Semilooper, *Cosmophila erosa* Hubn.	Milky	8–9 p.m.	–	–	–	1	–	–	2	–	–	3
18.	Swarming catterpillar, *Spodoptera mauritia* Boisd.	Milky	8–9 p.m.	–	–	1	–	2	–	–	–	–	3
		Blue	8–9 p.m.	–	–	–	–	–	–	–	2	–	2
19.	Juar stem-borer, *Chilo zonellus* Swinh.	Milky	11–12 p.m.	–	–	–	1	–	–	–	1	–	2
		TOTAL		437	475	493	435	395	324	263	213	111	3146

Sl. No.	Light	No. of insects attracted	Percentage of attraction.
1.	Milky	2486	79·05
2.	Bule	452	14·35
3.	Green	192	6·10
4.	Red	16	0·50
TOTAL		3146	100 00

ON A NEW AVIAN CESTODE BELONGING TO THE SUBFAMILY HYMENOLEPIDINAE PERRIER, 1897 FROM DELHI STATE.

By

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[Received on 11th January, 1961]

The material, forming the basis of this paper was obtained from the birds shot in Timarpur, Old Delhi. In one bird the intestine was badly choked with the worms and had affected serious damage by corroding the internal linning and submucosa.

The author is greatly indebted to the Council of Scientific and Industrial Research for the financial assistance in course of the investigations.

All measurements, unless mentioned otherwise, are given in mm.

Family HYMENOLEPIDIDAE Railliet and Henry, 1909.

Subfamily HYMENOLEPIDINAE Perrier, 1897.

HYMENOLEPIS Weinland, 1858.

Hymenolepis longiovata n.sp.

Host : *Erolia minuta minuta*

The maximum length of the specimens is 133·0 and the greatest breadth is 1·38 in mature segments and 2·5 in the gravid segments. The genital pores are unilateral and located in the anterior part of the proglottis.

The scolex is 0·209 long. The upper portion is conical while the region just below the suckers is the widest measuring 0·18. The posterior extremity of the scolex measures 0·105 in breadth. Suckers measure 0·10–0·116 in diameter. Acetabular hooks are present, the outermost spines on the free margins measure 0·003—0·004. Rostellum is 0·04 in diameter and carries ten rostellar hooks of 0·061 length. A rostellar sac is very well developed, extending below the lower margin of the suckers. It almost occupies the whole length of the scolex. It is 0·198–0·20 in length and 0·085 in width. A small neck is also present. In some cases it is very prominent.

The three testes are almost in a transverse row, the side ones are partly extending lateral to the longitudinal excretory vessels. They measure 0·21—0·34 in diameter. All the testes are not of the same size, sometimes a portion of the largest testis extends into the anterior segment. Cirrus sac is comparatively small, in the mature segments, measuring 0·09—0·12 × 0·045 and is not reaching the ventral longitudinal excretory vessels, its size is gradually increased where the formation of the uterus is quite prominent when it measures 0·194—0·20 × 0·07. Genital cloaca is very well developed and is provided with a muscular coat. It measures 0·09—0·10 × 0·065—0·08.

The ovary is transversely elongated in the lower half of the segment near the posterior border, thus it comes in close contact with all the testes. It is extending lateral to the longitudinal excretory vessels and is produced into small irregular lobes. It measures 0·07—0·097 × 0·004—0·007. A small vitelline gland measuring 0·07—0·10 × 0·03—0·04 is situated close to the ovary. A narrow vagina opens into the cloaca posterior to cirrus sac (Fig. E).

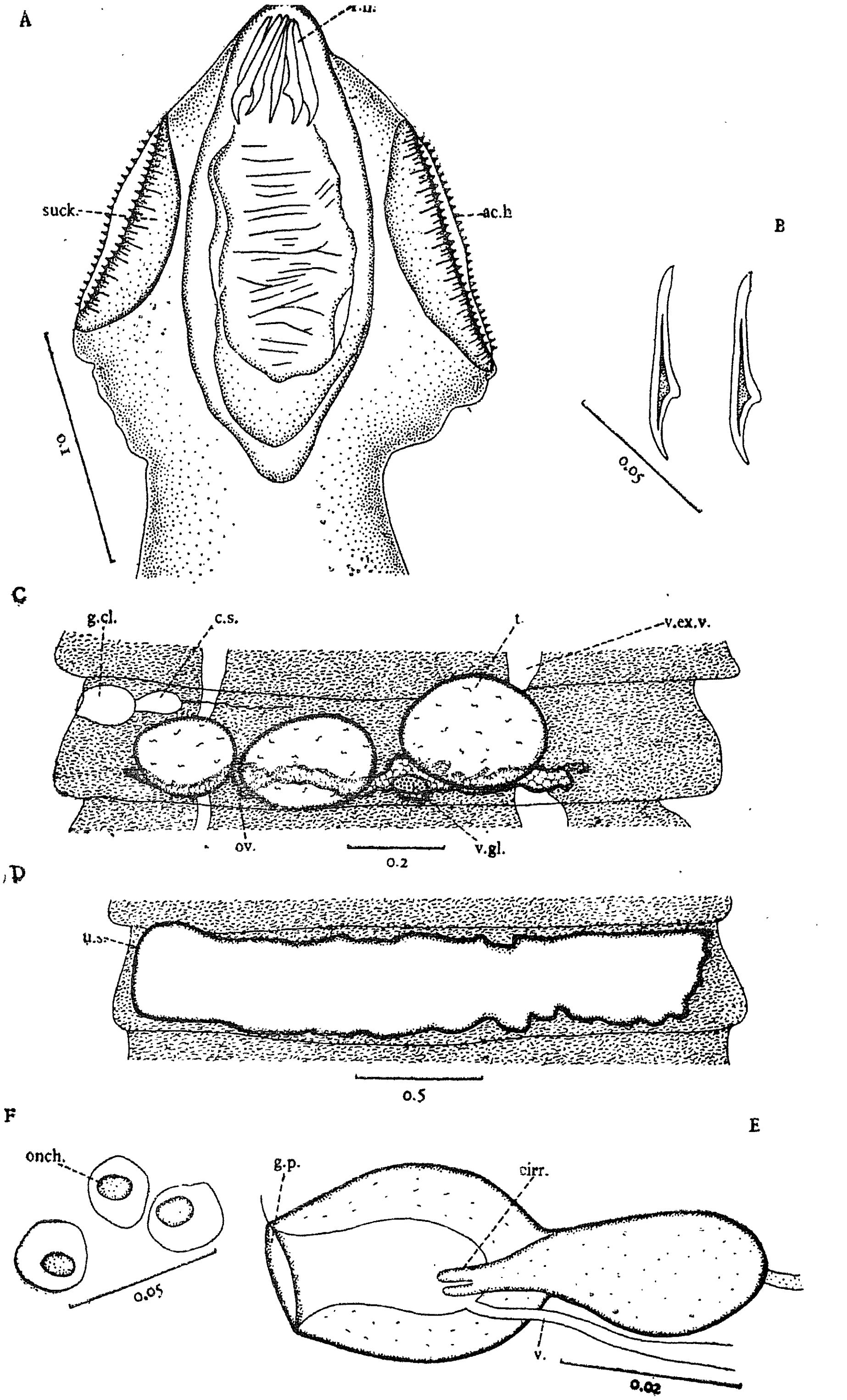

PLATE I. *Hymenolepis longiovata* n.sp.

A. Scolex. B. Rostellar hooks. C. Mature Segment. D. Gravid Segment. E. Genital cloaca and cirrus sac. F. Eggs.

ABREVIATIONS USED

ac.h. = acetabular hooks ; Cirr. = cirrus ; C.S. = cirrus sac ; g.cl. = genital cloaca ; g.p. = genital pore ; onch. = onchosphere ; ov. = ovary ; r.h. = rostellar hooks ; rost.s. = rostellar sae ; suck. = sucker ; t. = testis ; u.s. = uterine sac ; v. = vagina ; v.ex.v. = ventral longitudinal excretory vessel ; v.gl. = vitelline gland

The uterus is an irregularly lobed sac, extending beyond the longitudinal excretory vessels and is almost filling up the entire segment. The eggs are spherical and measure 0·022—0·024 in diameter. The onchospheres measure 0·01—0·013 in diameter.

While comparing the present form with all the species of the genus *Hymenolepis* Weinland 1858, *H. anatina* (Krabbe 1869), *H. compressa* (Linton 1892), *H. fructifera* (Meggitt 1927), *H. magnisaccis* Meggitt 1927, *H. naja* (Dujardin 1845), *H. pauciovata* Fuhrmann 1906, also Meggitt 1927 and *H. pearsi* Joyeux and Baer 1930 show an approach in the disposition of the three testes in a tranverse row together with the number and the size of the rostellar hooks. The possession of smaller number of rostellar hooks and the presence of acetabular hooks, size of the cirrus sac, disposition of the genital organs in the present form clearly distinguish it from *H. anatina* and *H. pauciovata.* A large and well developed genital cloaca, a very small cirrus sac and its relative size, greatly elongated ovary near posterior border of the segment, presence of the acetabular hooks in the present form clearly separate it out from the remainder of the species in the above mentioned list. *H. diorchis* Fuhrmann 1913, *H. falcata* Meggitt 1927, *H. floreata* Meggitt 1927, *H. parina* Fuhrmann 1907 and *H. trifolium* Linstow 1905 also resemble in the number and the size of the rostellar hooks but the arrangement of testes in these is quite different (not in a transverse row) and constitutes a different position with remainder of the genital organs. Besides their relative and absolute sizes show further distinguishing features and offer an easy process of elimination.

A new species, *H. longiovata* n.sp., is, therefore, created for its reception.

SUMMARY

Hymenolepis longiovata n.sp.

Host : *Erolia minuta minuta*

Maximum length 133·0 and the greatest breadth 1·38 (mature segments) and 2·5 (gravid segments). The genital pores unilateral. Scolex 0·209 long and 0·18 in maximum diameter. Suckers 0·10—0·116 in diameter. Acetabular hooks present. Rostellum 0·04 in diameter. Ten rostellar hooks each measuring 0·061 in length. Rostellar sac (0·20×0·085) occupying the entire length of the scolex. Testes three, sub-equal and arranged in a transverse row. Cirrus sac measures 0·09—0·12×0·045 (mature segments) and 0·194—0·20 (gravid segments). Genital cloaca very well developed, measuring 0·09—0·10×0·065—0·08. Ovary transversely elongated in the width of the segment and is in close contact with all the testes. Vitelline gland measures 0·07—0·1 in diameter. Uterus irregularly lobed sac almost filling the entire segment. Eggs and onchospheres measure 0·022—0·024 and 0 01—0·013 in diameter respectively.

The present form has been compared with the allied species of the genus *Hymenolepis* Weinland 1858. The possession of the acetabular hooks, enormously enlarged genital cloaca, the relative and the absolute size of the cirrus sac and the characteristic disposition of the ovary in the present form clearly distinguish it from all of them. A new species *H. longiovata* n.sp., is, therefore, created for its reception.

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DECIDUOUS FORESTS OF BELGAUM, WESTERN GHATS

By

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The present paper deals with the deciduous forests of Belgaum situated between latitude 15° 22′ N and 16° 58′ N and longitude 74° 2′ E and 75° 25′ E in the western ghats. Due to variation in climate, soil and geology, within the district the vegetation varies from semi-arid to evergreen type.

The area is mountainous, cut up by narrow valleys. The altitude ranges between 300–1000 meters above sea level. The western and southern regions along the Sahayadri hills are at higher altitudes. The principal rivers in the district are Krishna, Malprabha and Ghatprabha, flowing eastwards into Bay of Bengal (Fig. 1).

Geologically the area has unclassified rocks (granite, gneiss and laterites etc.), schists of auriferous Dharwar series ; and limestones of Kaladgi series and basalt belonging to the Deccan trap (Fig. 1). The soil varies according to the parent rock from which it is derived.

The climate of the area is typically monsoonic having an average rainfall of approximately 125 cms. The rainfall decreases from west to east (Chandgad 256 cms., Saundatti 50 cms.). The mean annual temperature of the area varies from 22°–30°C (Data based on 1950–60).

Vegetation :

The vegetation of area was studied by quadrat method (Misra and Puri, 1954). The size of the quadrat was determined by species—area curve method, that comes to be 6 m × 6 m for the deciduous forests. The deciduous forests at Sutgatti, Mangatti, Kattabali, Ukkad, Munoli, Gokak, Khanapur, Jamboti, Londa and Nagargalli are studied.

Deciduous forests commonly occur where conditions of low rainfall, high temperature and low humidity are prevalent. The area covered by the forests in this district is 14·09 percent of the whole area. The deciduous forests can be classified into two main types depending on the climate *i. e.*

(1) *Moist-deciduous forests*—Where both temperature and rainfall are moderate, dominant species are mainly deciduous but sub-dominants and lower storey species are mostly evergreen. Tree canopy is rarely dense but over 20 meters high.

(2) *Dry-dcideuous forests*—Where temperature is high and rainfall less, the forests are entirely deciduous or nearly so. The top canopy is not dense and is rarely over 20 meters high. Some of this type of forests cannot be called climatic but appear to be degraded forms of moist deciduous type due to biotic interference.

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For the present study, the deciduous forests are divided into following four types :

(i) *Teak forests.*

(ii) *Bamboo forests.*

(iii) *Teak-Bamboo forests.*

(vi) *Miscellanous forests without teak and bamboo.*

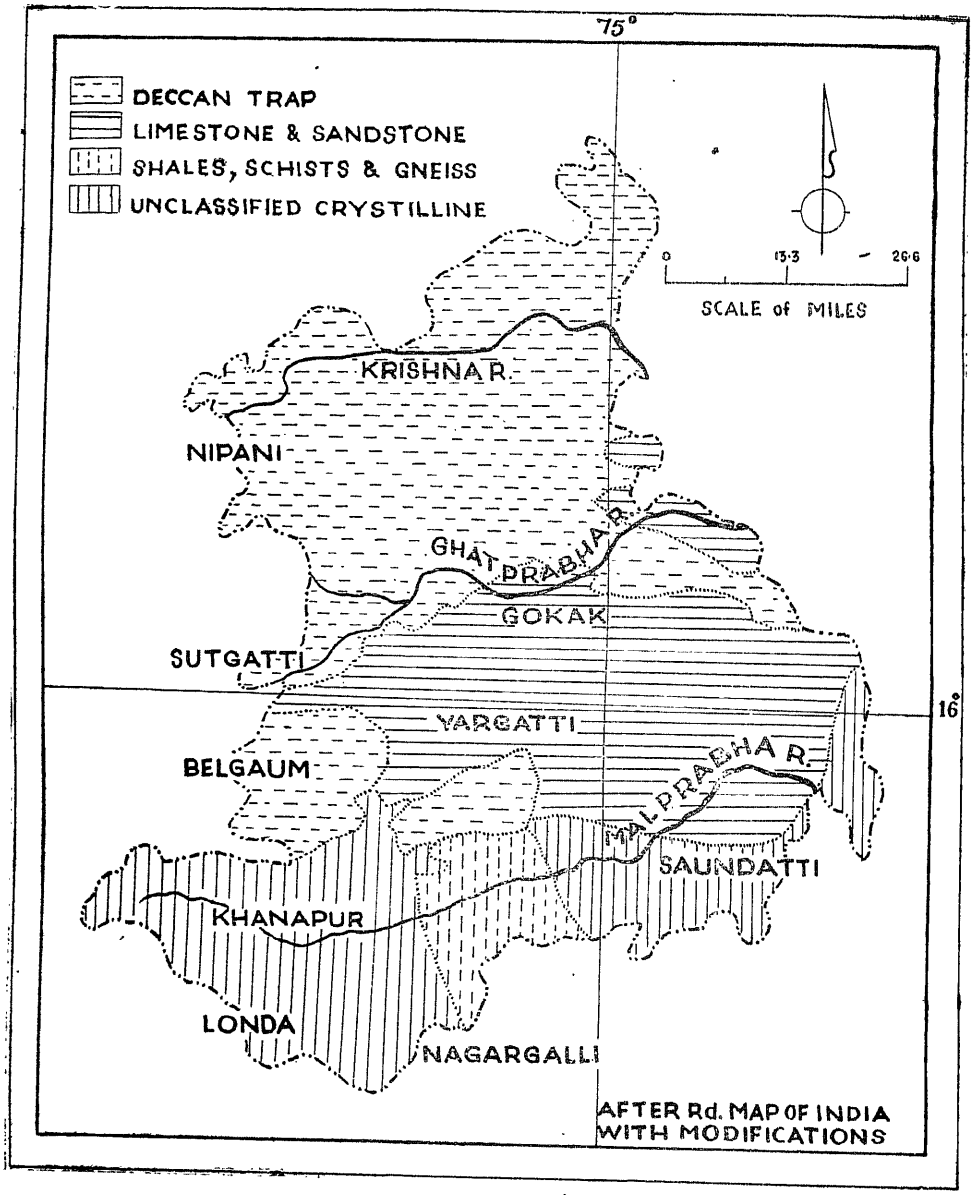

Fig. 1. Map of Belgaum district, showing types of rocks and main rivers.

Teak Forests :

Teak is capable of thriving on a variety of soils and geological formations, but requires good subsoil drainage. Although teak occurs in dry localities, subject to great heat and drought in the hot seasons, it thrives best and reaches its largest dimensons in a fairly moist, warm, tropical climate. In very moist-tropical regions it tends to be replaced by evergreen forests (Troup, 1921).

Mostly teak forests are situated on hilly or undulating country but there are several teak areas on flat well drained alluvials. Teak is most important constituent of the moist deciduous forests. Where the rainfall is less, the teak diminishes in size (in dry-deciduous forests).

The common associated tree species in the teak forests are *Anogeissus latifolia, Buchnania lanzan, Careya arborea, Cassia fistula, Chloroxylon swietenia, Emblica officinalis, Grewia tiliaefolia, Lagerstroemia lanceolata, Madhuca indica, Pterocarpus marsupium, Santalum album, Terminalia paniculata, Terminalia tomentosa*, and *Xylia xylocarpa*, etc.

The common climbers, shrubs and herbs in these forests are : *Carissa carandus, Cryptolepis buchnani, Cyclea fissicalyx, Randia dumetorum, Holarrhena antidysentrica, Lantana camara, Flacourtia indica, Dodonea viscosa, Microcos paniculata, Ixora coccinea, Zizyphus rugosus, Clerodendron serratum, Senecio tenuifolius, Sida acuta, Rungia parviflora, Elephantopus scaber*, etc.

TABLE I

Showing percentage of Teak in the communities studied at different places.

Community studied	Place	% frequency of Teak	No. of quadrats studied
Chloroxylon Teak	Mangutti	50	10
Chloroxylon-Teak-Lagerstroemia	Kattabali	80	10
Teak-Anogeissus-Chloroxylon	Sutgatti, Mangutti	100	20
Teak-Anogeissus-Grewia-Chloroxylon	Sutgatti	100	10
Teak-Terminalia	Ukkad, Londa, Nagargalli	100	30
Teak-Terminalia-Emblica	Ukkad, Nagargalli	100	20
Teak-Terminalia-Xxylia	Londa, Nagargalli	100	20

Bamboo Forests :

Bamboo is found typically in hilly areas. Sometimes it grows in pure stands. Usually, however, it forms understorey or a mixture with deciduous trees (moist deciduous forests). Bamboo prefers coarse grained dry soils such as those derived from sandstone, granite and granite gneisses. It avoids the more moist soils derived from pure quartzite, quartz, etc. Different conditions of soil, aspect, and drainage appear to have resulted in differentiation of recognisable growth forms. It thus appears that within its climatic habitat, *Dendrocalamus strictus* grows on particularly all types of soils provided there is good drainage. It does not grow on water logged or heavy soils such as pure clay or clay in mixture with lime. Well drained localities with sandy loam overlying boulders are the best for bamboo growth (Deogun, 1940).

The common tree species associated with bamboos are : *Maesa indica, Syzygium cuminii, Dillenia pentagyna, Careya arborea, Grewia tiliaefolia, Terminalia paniculata, Terminalia tomentosa, Lagerstroemia lanceolata, Emblica officinalis, Madhuca indica, Petrocarpus marsupium, Xylia xylocarpa*, etc.

The common herbs, shrubs and climbers in these forests are : *Asparagus racemosus, Wagatea spicata, Hemidesmus indicus, Dioscorea oppositifolia, Smilax macrophylla, Flacourtia indica, Clerodendron infortunatum, Elephantopus scaber, Sida spinosa, Urena lobata, Triumfetta bartramia*, etc.

TABLE II

Showing the percentage frequency of bamboo in the communities studied at different places

Community studied	Place	% frequency of Bamboo	No. of quadrats studied
Terminalia-Bamboo	Londa	70	10
Terminalia-Bamboo-Emblica	Londa, Nagargalli, Jamboti	60	30
Terminalia-Bamboo-Xylia	Londa, Khanapur, Nagargalli	60	30

Teak Bamboo Forests :

It has been noted that Teak and Bamboo prefer soils derived from sandstone, granite, granite gneisses and with good drainage. The mixed forests of teak and bamboo are very common in the area where both the above conditions are prevalent. Only one community *i.e.*, *Teak-Terminalia-Bomboo* community has been studied in the area.

The common plants associated with teak and bamboo in these forests are : *Terminalia paniculata, Terminalia tomentosa, Lagerstroemia lanceolata, Xylia xylocarpa Emblica officinalis, Grewia tiliaefolia, Asparagus racemosus, Wagatea spicata, Carissa carandus, Smilax macrophylla, Clerodendron infortunatum, Urena lobata, Rungia parviflora*, etc.

TABLE III

Showing the percentage frequency of teak and bamboo in the community studied

Community studied	Place	% frequency of Teak	% frequency of Bamboo	No. of quadrats studied
Teak-Terminalia-Bamboo	Londa, Khanapur, Nagargalli	90	80	30

Miscellaneous Forests without Teak and Bamboo :

This type refers to the forests where both teak and bamboo are absent. These forests were studied on the various type of rocks namely, trap, limestone, granite, gneiss and schists. The forests are low in the *East* where temperature is high with less rainfall while high forests are common in the *West* where conditions of high rainfall and moderate temperature are prevalent. The composition of these forests varies to a great extent depending on the climate and geology, These forests can be divided into two main types :

(1) Dry-deciduous forests (in the east).

(2) Moist deciduous forests (in the west).

The common plants in the dry deciduous forests are : *Anogeissus latifolia, Bauhinia racemosa, Albizzia amara, Bridelia retusa, Diospyros melanoxylon, Dodonea viscosa, Chloroxylon swietenia, Euphorbia nivulia, Flacourtia indica, Gmelina arborea, Hardwickia binata, Ixora parviflora, Lagerstroemia parviflora, Lantana camara, Mundulea suberosa Schleichera oleosa, Zizyphus oenoplea,* etc.

The common plants in the moist deciduous forests are : *Buchnania lanzan, Cassia fistula, Erinocarpus nimonii, Xydia calycina, Terminalia paniculata, Terminalia tomentosa, Emblica officinalis, Kylia xylocarpa, Lagerstroemia lanceolata, Strychnos nux-vomica, Santalum album, Carissa carandus, Careya arborea, Dillenia pentagyna, Randia brandisii, Lantana camara, Securinega virosa, Gardenia lucida, Clematis gouriana, Ixora coccinea, Dioscorea oppositifolia,* etc.

TABLE IV

Showing percentage frequency of *Terminalia* and *Chloroxylon* in the communities studied at different place

Community studied	Place	% frequency of *Terminalia*	% frequency of *Chloroxylon*	No. of quadrats studied
Terminalia-Xylia	Nargargalli, Londa	100	—	20
Terminalia-Emblica	Ukkad, Nagargalli	100	—	20
Chloroxylon-Anogeissus	Gokak	—	100	10
Chloroxylon-Anogeissus Albizzia	Gokak, Munoli	—	80	20

DISCUSSION

The topographical, climatic and geological factors have a direct bearing on the types of forests. The forests are low in the eastern region where rainfall is less with high temperature in comparison to the high forests of western region where rainfall is high with a moderate temperature.

Succession is progressive ; this can be shown with an example of Teak ; teak is not well developed in dry deciduous forests but is well developed in moist deciduous forests, while it is occasionally noted in the evergreen and semi-evergreen.

Scrub → Dry-deciduous → Moist-deciduous → Evergreen.

Succession in the area is as follows :

Evergreen — **Evergreen forest**

↑

Terminalia-Xylia

↗ ↑ ↖

Terminalia-Bamboo-Xxylia — *Teak-Terminalia Xylia* — *Terminalia-Bamboo*

↖ ↑ ↗

Teak-Terminalia-Bamboo

↗ ↖

Moist-deciduous — *Teak-Terminalia* — *Terminalia-Emblica*

↘ ↗

Teak-Terminalia-Emblica

↑

Teak-Anogeissus Chloroxylon
Teak-Anogeissus-Grewia-Chloroxylon

↑

Dry-deciduous — *Chloroxylon-Teak-Lagerstroemia*

↑

Chloroxylon-Teak

↑

Chloroxylon-Anogeissus

↑

Chloroxylon-Anogeissus-Albizzia

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ON A NEW SPECIES OF THE GENUS ECHINOPARYPHIUM DIETZ, 1909 (TREMATODA : ECHINOSTOMATIDAE)

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[Received on 29th March, 1961]

INTRODUCTION

Sixty-two parasites of *Echinoparyphium indicum* n. sp. were collected from the intestine of a bird, *Neophron percnopterus* (Linnaeus) shot from Bal Sagar locality, which is 6 miles away from Jabalpur city. The present paper deals with the details of its morphology.

Echinoparyphium indicum n. sp.

The worms are slender, medium sized, measuring 5·88* to 8·62 in length and 1·31 to 1·87 in breadth, the maximum breadth being in the region of the ventral sucker. Its cuticle is coverd with spines extending to the anterior level of the ovary. The cuticular spines measure 0·009 to 0·016 in length and 0·003 to 0·006 in breadth.

The collar is kidney shaped, measuring 0·172 to 0·235 in length and 0·298 to 0·345 in breadth. Collar spines thirty-eight in number, arranged in two rows, uninterrupted dorsally and the spines of the oral row are slightly bigger than the spines of the aboral row. The spines of the oral row measure 0·036 to 0·042 in length and 0·006 to 0·009 in breadth, while the spines of the aboral row measure 0·026 to 0·033 in length and 0·006 to 0·008 in breadth. The end group consists of four spines on each side, measuring 0·039 to 0·062 in length and 0·013 to 0·019 in breadth (much larger than the spines of the oral and aboral rows).

Mouth is encircled by the oral sucker. Oral sucker measuring 0·049 to 0·099 in length and 0·066 to 0·099 in breadth ; ventral sucker pre-equatorial, measuring 0·322 to 0·392 in length and 0·274 to 0·392 in breadth. Prepharynx present, measuring 0·046 to 0·072 in length and 0·003 to 0·009 in breadth ; pharynx well developed, measuring 0·072 to 0·082 in length and 0·049 to 0·069 in breadth ; oesophagus of moderate size, measuring from 0·066 to 0·171 in length and 0·003 to 0·009 in breadth : intestinal caeca simple and extending to a little above the posterior end of the body.

Testes tandem, smooth and ovoid ; anterior testis situated from 0·157 to 0·361 from the posterior border of the ventral sucker and measuring 0·267 to 0·343 in length and 0·235 to 0·298 in breadth. Posterior testis touching the posterior border of anterior testis or lying 0·015 to 0·125 away from the latter. The posterior testis measures 0·282 to 0·376 in length and 0·235 to 0·314 in breadth. Cirrus sac oval, situated between intestinal bifurcation and acetabulum, and in some cases partly overlapping the anterior margin of acetabulum. In one case it extends to the level of the middle of ventral sucker. Cirrus sac measuring 0·148 to 0·33 in length and 0 082 to 0·138 in breadth ; it includes a large vesicula seminis, small

*All measurements are given in mill'meters. Measurements are based on the study of 5 specimens, while the general observations refer to a study of 22 parasites.

pars-prostatica and long retractile cirrus. Vesicula seminis measuring 0·141 to 0·264 in length and 0·079 to 0·128 in breadth ; cirrus is non-spiny.

Ovary median or slightly submedian, situated 0·062 to 2·282 behind the posterior border of the ventral sucker, measuring 0 094 to 0·133 in length and 0·109 to 0·141 in breadth. The oviduct arises from the inner margin of the ovary. Receptaculum seminis measuring 0·033 to 0·042 in length and 0·019 to 0·029 in breadth, and opening in the oviduct. Mehlis' gland lying posterior to the receptaculum seminis and measuring 0·066 to 0·075 in length and 0·062 to 0·082 in breadth. Eggs few in number (7 to 10), measuring 0·082 to 0·095 in length and 0·042 to 0·049 in breadth.

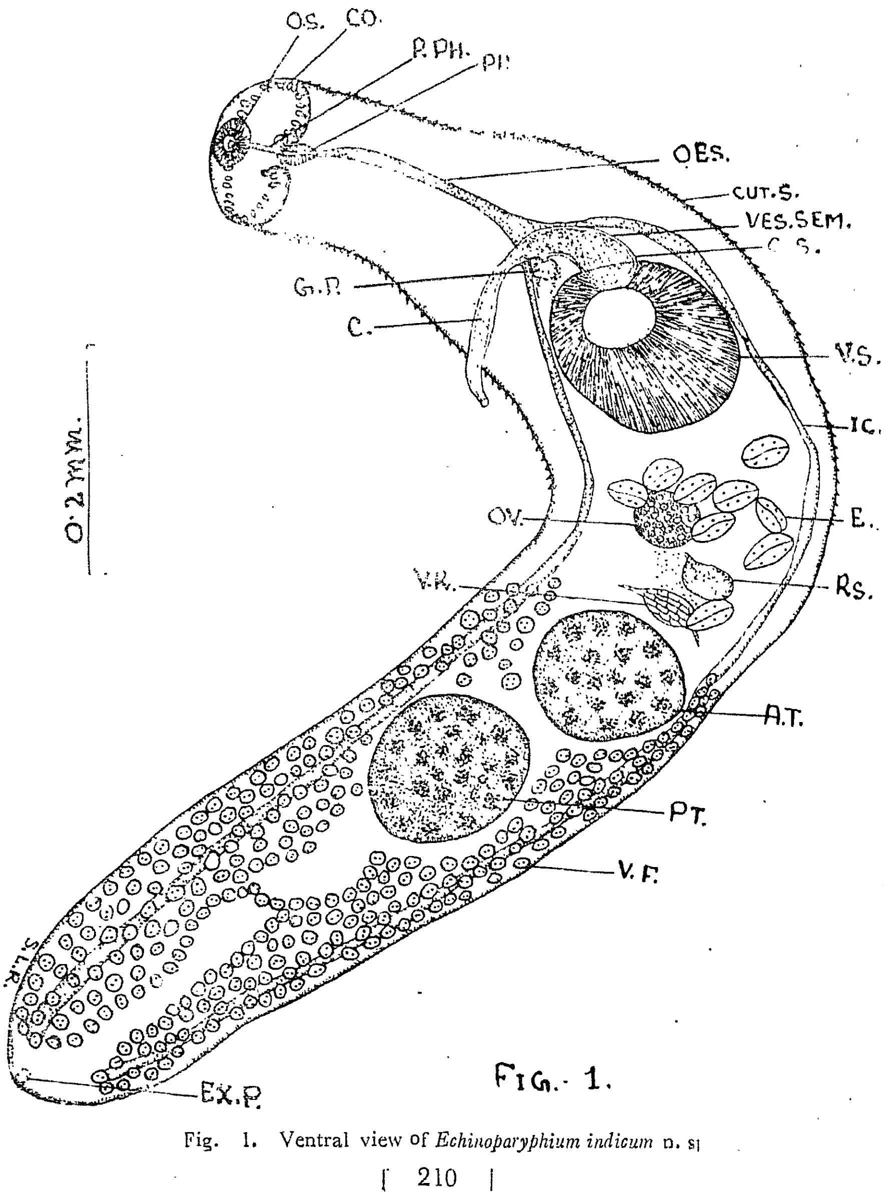

FIG.- 1.

Fig. 1. Ventral view of *Echinoparyphium indicum* n. sp.

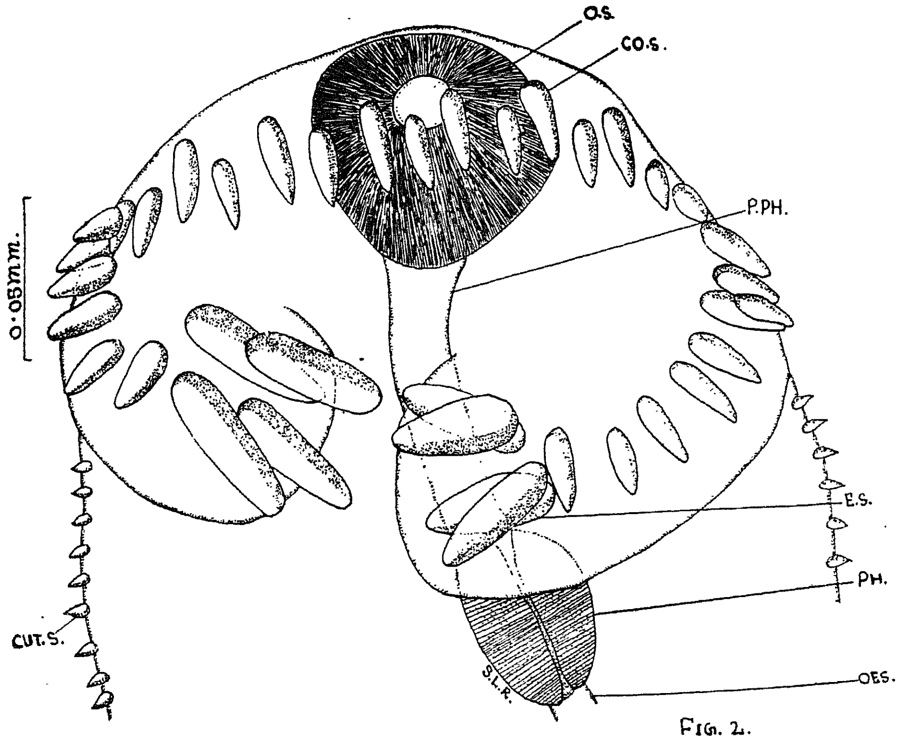

Fig. 2, Collar region showing the details of the arrangement of collar spines.

KEY TO THE LETTERINGS

A. T.—Anterior testis ; CO. S —Collar spines ; C. S.—Cirrus sac. ; E.—Egg ; EX. P.—Excretory pore ; E. S. —End spine ; G. P.—Genital pore ; I. C.—Intestinal caeca ; OES.—Oesophagus ; O. S.—Oral sucker ; OV.—Ovary ; P. Ph.—Prepharynx ; Ph.—Pharynx ; P. T.—Posterior testis ; V. F. —Vitelline follicles ; V. S.—Ventral sucker ; V. SEM.—Vesicula seminis.

Vitelline follicles extending anteriorly to the anterior level of the anterior testis and posteriorly to a little above the posterior end of the body. The follicles of the two sides either distinctly separate or confluent at a few places in the post testicular region. The follicles of the two sides open in the vitelline reservoir through their transverse ducts. Vitelline reservoir prominent, measuring 0·033 to 0·069 in length and 0·082 to 0·089 in breadth, and lying in front of the anterior testis. From the anterior side of the vitelline reservoir a duct arises which joins the Mehlis' gland.

Excretory bladder is of typical echinostome type and the excretory pore lies at the posterior end of the body.

REMARKS

Yamaguti (1958) established a new genus, *Neoacanthoparyphium*, distinguishing it from the very closely similar genus, *Echinoparyphium* Dietz, 1909 principally on the basis of anterior extension of vitelline follicles and the pre-equatorial position of the acetabulum. Agarwal (1959) did not agree with Yamaguti's contention in

view of the fact that anterior extension of vitelline follicles is a variable character in many genera of Echinostomes and suggested the synonymy of *Neoacanthoparyphium* Yamaguti with *Echinoparyphium* Dietz. The present author is in complete agreement of Agarwal's (1959) contention and supports the dropping of *Neoacanthoparyphium* as a synonym of *Echinoparyphium* Dietz.

The present form, however, differs from *E. petrowi* Nevostrueva, 1953 in the much smaller number of its collar spines, disposition of vitelline follicles in the post testicular region, and in the position of the cirrus sac. It also differes from *E. dollfusi* Agarwal, 1959 in the greater number of its collar spines, presence of receptaculum seminis, presence of prominent vitelline reservoir, and its larger body size, etc. The above differences from *E. petrowi* and *E. dollfusi* are pertinent to justify the erection of a new species, *E. indicum* to include the present form.

ACKNOWLEDGEMENTS

The author is thankful to Dr. R. N. Singh, Reader and Head of the Depart ment of Zoology, for his guidance and to Professor U. D. Mukerjee, Principal, for facilities in the institution. Thanks are also due to Government of India for awarding a Senior Research Fellowship and to the Jabalpur University authorities for a research grant.

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FISHES OF KANPUR DISTRICT

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INTRODUCTION

The data of systematics of fresh-water fishes of Uttar Pradesh is very meagre. Inspite of the fact that the science of Ichthyology is fast developing and much work is being done in different Universities and other Zoological Institutions of the state, enough literature is not available on the availabilty of fishes in different regions. As far as we understand the only available account is that by Hora (1936) on the 'Fishes of Doon Valley', Menon (1949) on the 'Fishes of Kumaon Himalaya', Sinha and Shiromany (1953) on the 'Fishes of Meerut', Moitra (1957) on the 'Fishes of Lucknow', and Mahajan (1961) on the 'Fishes of Muzaffarnagar. So to fill up the gap existing in the literature we have undertaken to describe the Fishes of the remaining districts of Uttar Pradesh. In the present work an attempt has been made to record the species of Kanpur District according to recent scientific nomenclature and systematic position, their distribution and prevelant vernacular names.

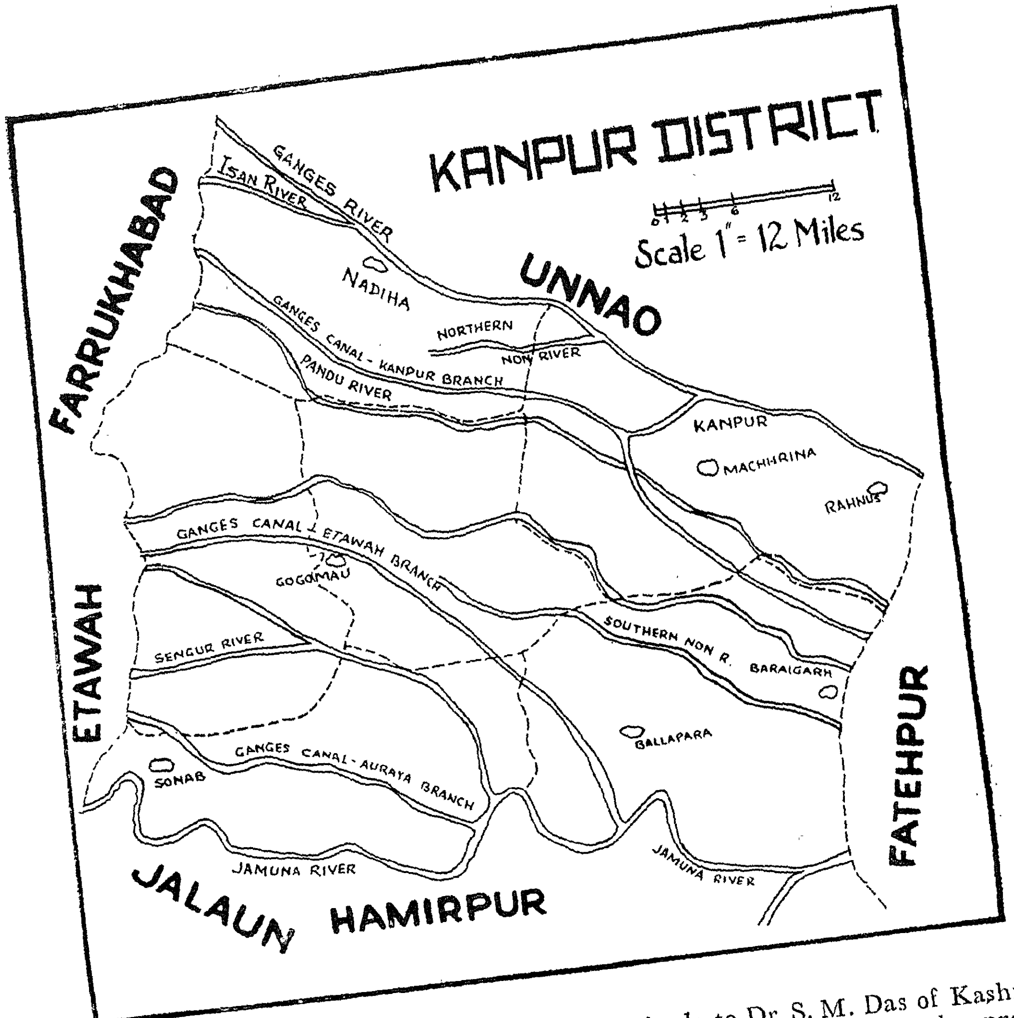
In all 52 different species of fishes belonging to 31 genera and 18 families available in Kanpur District have heen recorded. Most of the species are well known and are widely distributed, but there are a few which occur rarely.

Kanpur District is situated centrally in Uttar Pradesh and the surface of the District is more or less evenly plain with slight undulations and no hills. The elevation from the sea level is 122 metres. The average annual rain-fall is 104 cms. The temperature of the air varies from 4°C to 48°C and that of waters varies from 8°C to 38°C. The main water bodies in the District are : (*i*) rivers, the Ganges, the Jamuna, the Sangur, the Rhind the Pandov, the Isan and the South and North Non ; (*ii*) Canals of the Ganges, Kanpur, Etawah and Auraiya branches ; (*iii*) Lakes : the Gogomau, the Machhriha, the Rahnus, the Sonab, the Ballapara, the Baraigarh and the Nadiha ; and (*iv*) many perennial ponds and tanks scattered all over the district.

The collections were made from different localities personally by the authors with the help of local fishermen. Some specimens were also obtained from local markets. The local vernacular names were obtained from the fishermen of the locality.

Most of the species recorded here are found throughout the district, but in view of the abundance some of the species are more common than others, whilest a few species are rare. The most common species of the district are *Catla catla* (Ham.), *Cirrhina mrigala* (Ham.), *Clarias batrachus* (Linn.), *Heteropneustes fossilis* (Bloch), *Mystus seenghala* (Sykes) and *Channa striatus* (Bloch). The fishes rare in the district are *Mystus bleekeri* (Day), *Aspidoparia Jaya* (Ham.), *Botia dario* (Ham.), *Pangasius pangasius* (Ham.), *Clupisoma murius* (Ham.), *Xenentodon cancilla* (Ham), *Channa stewartii* (Playfair) and *Sciaena coitor* (Ham.).

Botia dario (Ham.), *Aspidoparia jaya* (Ham.), *Clupisoma murius* (Ham.) and *Channa stewartii* (Playfair) have not been reported from Uttar Pradesh in the earlier papers. The maximum length of different species available in the district is given in milimeters. The fishes were measured from the tip of the snout to the origin of the base of the caudal fin.



The authors wish to acknowledge their gratitude to Dr. S. M. Das of Kashmir University for his constant encouragement and valuable suggestions in the preparation of this paper. We wish to thank Shri R. K. Saxena for his kind help.

Species	*Vernacular Names*
1. Family ... **Clupeidae** :	
1. Hilsa ilisha** (Ham.)	Hilsa.
2. Family ... **Notopteridae** :	
2. Notopterus notopterus* (Pallas)	Moh.
3. Notopterus Chitala* (Ham.)	Patra, Chitala.
3. Family ... **Cyprinidae** :	
4. Oxygaster bacaila* (Ham.)	Chilwa.
5. Esomus dandricus* (Ham.)	Derwa.

	Species	*Vernacular Names*
6.	Aspidoparia morar* (Ham.)	Peora.
7.	Aspidoparia jaya** (Ham.)	Jaya.
8.	Puntius sarana (Ham.)	Darhi.
9.	Puntius chagunio (Ham.)	Utta.
10.	Puntius sophore (Ham.)	Unti.
11.	Puntius ticto (Ham.)	Unti.
12.	Catla catla (Ham.)	Bhakur, Katla.
13.	Cirrhina mrigala (Ham.)	Nain, Mirgal.
14.	Cirrhina reba (Ham.)	Reba.
15.	Labeo bata (Ham.)	Bata.
16.	Labeo calbasu (Ham.)	Karonch.
17.	Labeo rohita (Ham.)	Rohu.
18.	Labeo gonius (Ham.)	Khursa.
19.	Rohtee cotio (Ham.)	Khurri.
4. Family ...	**Cobitidae** :	
20.	Nimach ilus botio* (Ham.)	Carri.
21.	Botia dario** (Ham.)	
5. Family ...	**Claridae** :	
22.	Clarias batrachus (Linn.)	Magur.
6. Family ...	**Heteropneustidae** :	
23.	Heteropneustes fossilis (Bloch)	Singi.
7. Family ...	**Siluridae** :	
24.	Callichrous pabda (Ham.)	Pabda.
25.	Callichrous bimaculatus (Bloch)	Pabda.
26.	Wallagonia attu (Bloch)	Parhan.
8. Family ...	**Schilbeidae** :	
27.	Pangasius pangasius** (Ham.)	Pangas.
28.	Eutropiichthys vacha (Ham.)	Butchwa.
29.	Eutropiichthys murius** (Ham.)	Golmuhi.
30.	Silonia silondia (Ham.)	Siland.
31.	Clupisoma garua (Ham.)	Baikari.
9. Family ...	**Bagridae** :	
32.	Mystus cavasius (Ham.)	Katar.
33.	Mystus vittatus (Bloch)	Tengana.
34.	Mystus menoda (Ham.)	Tengri.
35.	Mystus bleekeri** (Day)	
36.	Mystus seenghala (Sykes)	Tengan, Macrones.

Species	Vernacular Names
37. Mystus aor (Ham.)	
38. Rita rita (Ham.)	Ritha, Belgara.
10. Family ... **Sisoridae** :	
39. Bagarius bagarius* (Ham.)	Gaunch.
11. Family ... **Xenentodontidae** :	
40. Xenentodon cancilla** (Ham.)	Kawai.
12. Family ... **Ophiocephalidae** :	
41. Channa striatus (Bloch)	Kawar.
42. Channa punctatus (Bloch)	Hirai.
43. Channa gachua (Ham.)	
44. Channa stewartii** (Playfair)	
13. Family ... **Centropomidae** :	
45. Ambassis nama (Ham.)	Chanua.
46. Ambassis ranga (Ham.)	Pattari.
14. Family ... **Sciaenidae** :	
47. Sciaena coitor** (Ham.)	Adwari.
15. Family ... **Nandidae** :	
48. Nandus nandus* (Ham.)	Chepti.
16. Family ... **Osphronenidae** :	
49. Colisa fasciatus (Bloch)	Khurda, Kawai.
17. Family ... **Gobidae** :	
50. Glossogobius giuris (Ham.)	Rajabhujji.
18. Family ... **Mastacembalidae** :	
51. Mastacembalus armatus* (Lacep.)	Bam.
52. Mastacembalus pancalus* (Ham.)	Bahru.

SYSTEMATIC ACCOUNT

Class—Teleostomi.

Sub-class—Actinopterygii.

Order I—Clupeiformes.

Sub-order (*a*)—Clupeoidea.

(*i*) Family—*Clupeoidae.*

1. Hilsa ilisha (Hamilton)

1822. *Clupanodon ilisa* Hamilton, *Fish Ganges*, 243, 382.

1878. *Clupea ilisa* Day, *Fish India*, **1** : 610.

1937. *Hilsa ilisa*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.* **3** : 13.

* Few.
** Rare.

D. 18–20 ; P. 15 ; V. 9 ; A. 19–22 ; C. 19 ; L. l. 46–49.

Max. Size :— 200 mm.

Distribution : Found on the coast of Sind, India and Burma, passing up the large rivers to breed, also in the Malaya archipelago, reported by Day from Delhi and Hamilton Buchanan from Agra and Kanpur.

Sub-order (*b*) —Notopteroidea.

(*ii*) Family—*Notopteridea.*

2. **Notopterus notopterus** (Pallas)

1822. *Mystus kapirat*, Hamilton, *Fish Ganges*, 235, 382.

1878. *Notopterus kapirat*, Day, *Fish India* **1** : 653.

1937. *Notopterus notopterus*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** ; 16.

1953. *Notopterus notopterus*, Sinha and Shiromany, *Rec. Indian Mus.* **51**(1) : 62.

1957. *Notopterus notopterus*, Moitra, *Uttara Bharati*, **3**(1) : 44.

D. 7–8 ; P. 17 ; V. 5-6 ; A. 100–110 ; C. 19 ; L. l. 225.

Max. Size :—450 mm.

Distribution : Found in fresh and brackish waters of India to the Malaya archipelago.

3. **Notopterus chitala** (Hamilton)

1822. *Mystus chitala*, Hamilton, *Fish Ganges*, 236.

1878. *Notopterus chitala*, Day, *Fish India* **1** : 654.

1937. *Notopterus chitala*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 15.

1953. *Notopterus chitala*, Sinha and Shiromany, *Rec. Indian Mus.*, **51**(1) : 62.

1957. *Notopterus chitala*, Moitra, *Uttara Bharati*, **3**(1) : 44.

D. 9–10 ; P. 16 ; V. 5–6 ; A. 110–125 ; C. 12–14 ; L. l. 180.

Max. Size :—1050 mm.

Distribution : Found in fresh waters of Sind, Northern India, Assam, Burma and Siam to the Malaya archipelago.

Order II—Cypriniformes.

Sub-order (*c*)—Cyprinoidea.

(*iii*) Family—*Cyprinidae.*

4. **Oxygaster bacaila** (Hamilton).

1822. *Cyprinus bacaila* Hamilton, *Fish Ganges*, 265, 384.

1878. *Chela bacaila*, Day, *Fish India*, **1** : 603.

1937. *Chela bacaila*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 19.

1953. *Oxygaster bacaila*, Chauhan and Rama Krishna, *Rec. Indian Mus.*, **51**(3) : 399.

1957. *Oxygaster bacaila*, Moitra, *Uttara Bharati*, **3**(1) : 44.

D. 9 ; P. 13 ; V. 9 ; A. 13–15 ; C. 19 ; L. l. 86–110.

Max. Size :—125 mm.

Distribution : Throughout India except Malabar, Mysore, Madras and part of Deccan.

5. Esomus dandricus (Hamilton)

1822. *Cyprinus dandrica* Hamilton, *Fish Ganges*, 325, 391.

1867. *Esomus malabaricus*, Day, *Proc. Zool. Soc.* 299, 300.

1878. *Nuria dandrica*, Day, *Fish India* **1** : 583.

1937. *Esomus dandricus*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 29–30.

1938. *Esomus dandricus*, Hora, *Rec. Indian Mus.*, **40**(2) : 173.

1953. *Esomus dandricus*, Sinha and Shiromany. *Rec. Indian Mus.*, **51**(1) : 62.

1957. *Esomus dandricus*, Moitra, *Uttara Bharati*, **3**(1) : 45.

D. 8 (2/6) ; P. 15 ; V. 9 ; A. 8 (3/5) ; L. l. 30–34.

Max. Size :—100 mm.

Distribution : Found in the smallest streams, ponds and ditches, common during rains, available throughout India, Ceylon, Burma and Nicobars.

6. Aspidoparia morar (Hamilton)

1878. *Aspidoparia morar*, Day, *Fish India*, **1** : 585.

1841. *Leuciscus morar*, Sykes, *Proc. Zool. Soc.* 363

1837. *Aspidoparia morar*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 33.

1938. *Aspidoparia morar*, Hora, *Rec. Indian Mus.*, **40**(2) : 173.

1953. *Aspidoparia morar*, Sinha and Shiromany, *Ibid.* **51**(1) : 62.

1957. *Aspidoparia morar*, Moitra, *Uttara Bharati*, **3**(1) : 46.

D. 9–10 (2–3/7–8) ; P. 15 ; V. 8 ; A. 10–12 (2/8–10) ; C. 19 ; L. l. 38–42.

Max. Size :—130 mm.

Distribution : Found in Sind, throughout India except the Western coast and the localities South of Krishna river also in Assam and Burma.

7. Aspidoparia jaya (Hamilton)

1822. *Cyprinus jaya*, Hamilton, *Fish Ganges*, 333, 392.

1878. *Aspidoparia jaya*, Day, *Fish India*, **1** : 585.

1937. *Aspidoparia jaya*, Shaw and Shebbeare, *J. Asiat. Soc. Bengol Sci.* **3** : 33.

D. 9 (2/7 ; P. 15 ; V. 8 ; A. 9 (2/7) ; C. 21 ; L. l. 52–60.

Max. Size :— 80 mm.

Distribution : According to Day, Hardwar on the Ganges and Assam. Shaw and Shebbeare reported from Malangi river in Central Duars.

8. **Puntius sarana** (Hamilton)

1822. *Cyprinus sarana*, Hamilton, *Fish. Ganges*, 307, 388
1860. *Barbus candimarginatus*, Blyth, *J. Asiat. Soc. Bengal*, 157.
1878. *Barbus sarana*, Day, *Fish. India*, **1** : 560.
1937. *Barbus sarana*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 41.
1952. *Puntius sarana*, Menon, *Rec. Indian Mus.*, **50** : 268
1957. *Puntius sarana*, Moitra, *Uttara Bharati*, **3**(1) : 46.

D. 4/7 ; P. 1/13 ; V. 1/8 ; A. 2/6 ; C. 6/17 ; L. l. 32–34.

Max. Size :—250 mm.

Distribution : Common in India and Burma.

9. **Puntius chagunio** (Hamilton).

1822. *Cyprinus chagunio*, Hamilton, *Fish. Ganges*, 295, 387.
1878. *Barbus chagunio*, Day, *Fish. India*, **1** : 559.
1937. *Barbus chagunio*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 35.
1953. *Puntius chagunio*, Sinha and Shiromany, *Rec. Indian Mus.*, **51**(1) : 63.

D. 3/8 ; P. 15 ; V. 9 ; A. 3/5 ; C. 19 ; L. l. 44–47.

Max. Size :—350 mm.

Distribution : From Orissa throughout Bengal, Assam, Bihar and North-west Provinces.

10. **Puntius sophore** (Hamilton).

1822. *Cyprinus sophore*, Hamilton, *Fish. Ganges*, 310, 389.
1878. *Barbus stigma*, Day, *Fish. India*, **1** : 579.
1937. *Barbus stigma*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 42.
1938. *Barbus sophore*, Hora, *Rec. Indian Mus.*, **40**(2) : 174.
1953. *Puntius sophore*, Chauhan and Rama Krishna, *Ibid*, **51**(3) : 405.
1957. *Puntius sophore*, Moitra, *Uttara Bharati*, **3**(1) : 46.

D. 3/8–9 ; P. 17 ; V. 9 ; A. 3/5 ; C. 19 ; L. l. 23–26.

Max. Size :—90 mm.

Distribution : Found in fresh and brackish waters of India and Burma.

11. **Puntius ticto** (Hamilton).

1822. *Cyprinus ticto*, Hamilton, *Fish. Ganges*, 314, 389.
1878. *Barbus ticto*, Day, *Fish. India*, **1** : 577.
1937. *Barbus ticto*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 43.

1938. *Barbus ticto*, Hora, *Rec. Indian Mus.*, **40**(2) : 175.

1952. *Puntius ticto*, Menon, *Ibid.*, **50** : 268.

1953. *Puntius ticto*, Sinha and Shiromany, *Ibid.*, **51**(1) : 65.

1957. *Puntius ticto*, Moitra, *Uttara Bharati*, **3** : 46.

D. 3/8 ; P. 15 ; V. 9 ; A. 2/5 ; C. 19 ; L. 1. 23–26.

Max. Size :—50 mm.

Distribution : Found throughout India and Ceylon.

12 **Catla catla** (Hamilton).

1822. *Cyprinus catla*, Hamilton, *Fish. Ganges*, 287, 318.

1878. *Catla buchanani*, Day, *Fish. India*, **1** : 553.

1937. *Catla catla*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.* **3** : 44.

1938. *Catla catla*, Hora, *Rec. Indian Mus.*, **40**(2) ; 175.

1953. *Catla catla*, Sinha and Shiromany, *Ibid.*, **51**(1) : 62.

1957. *Catla catla*, Moitra, *Uttara Bharati*, 3(1) : 46.

D. 3-4/14–16 ; P. 21 ; V. 9 ; A. 3/5 ; C. 19 ; L. 1. 38–43.

Max. Size :—1000 mm.

Distribution : Found in fresh and brackish waters of India and Burma.

13. **Cirrhina mrigala** (Hamilton).

1822. *Cyprinus mrigala*, Hamilton, *Fish. Ganges*, 279, 386.

1878. *Cirrhina mrigala*, Day, *Fish. India*, **1** : 547–48.

1911. *Cirrhina mrigala*, Chaudhari, *Rec. Indian Mus.*, **31** : 194.

1929. *Cirrhina mrigala*, Prasad and Mukerji, *Ibid.*, **31** : 194.

1937. *Cirrhina mrigala*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 45.

1953. *Cirrhina mrigala*, Sinha and Shiromany, *Rec. Indian Mus.*, **51**(1) : 62.

1957. *Cirrhina mrigala*, Moitra, *Uttara, Bharati*, **3**(1) : 46–47.

D. 3/12–13 ; P. 15 ; V. 9 ; A. 3/5 ; C. 15 ; L. 1. 40-45.

Max. Size :—500 mm.

Distribution : Found in rivers and tanks of Northern India and Burma.

14. **Cirrhina reba** (Hamilton).

1822. *Cyprinus reba*, Hamilton, *Fish. Ganges*, 280, 386.

1849. *Cirrhina reba*, Cuvier and Valenciennes, *Hist Nat. Poissons*, **XVI** : 291.

1878. *Cirrhina reba*, Day, *Fish. India*, **1** : 549.

1937. *Cirrhina reba*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*. **3** : 46.

1938. *Cirrhina reba*, Hora, *Rec. Indian Mus.*, **40**(2) : 175.

1953. *Cirrhina reba*, Sinha and Shiromany, *Ibid.*, **51**(1) : 62.

1953. *Cirrhina reba*, Chauhan and Rama Krishna, *Ibid.*, **51**(3) · 406.

1957. *Cirrhina reba*, Moitra, *Uttara Bharati*, **3**(1) : 46.

D. 3/9 ; P. 1/18 ; V. 1/9 ; A. 2/6 ; C. 19 ; L. 1. 35–38.

Max. Size :—200 mm.

Distribution : Throughout India.

15. Labeo bata (Hamilton).

1822. *Cyprinus bata*, Hamilton, *Fish. Ganges*, 283, 386.

1878. *Labeo bata*, Day, *Fish. India*, **1** : 542.

1937. *Labeo bata*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 50.

1938. *Labeo bata*, Misra, *Rec. Indian Mus.*, **11** : 261.

1957. *Labeo bata*, Moitra, *Uttara Bharati*, **3**(1) : 47.

D. 2–3/9–10 ; P. 18 ; V. 9 ; A. 2/5 ; C. 19 ; L. 1. 37–40.

Max. Size :—325 mm.

Distribution : Found throughout India and Assam.

16. Labeo calbasu (Hamilton).

1822. *Cyprinus calbasu*, Hamilton, *Fish. Ganges*, 297, 387.

1878. *Labeo calbasu*, Day, *Fish. India*, **1** : 536–37.

1937. *Labeo calbasu*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 52.

1953. *Labeo calbasu*, Sinha and Shiromany, *Rec. Indian Mus.*, **51**(1) : 62.

1953. *Labeo calbasu*, Chauhan and Rama Krishna, *Ibid.*, **51**(3) : 407.

1957. *Labeo calbasu*, Moitra, *Uttara Bharati*, **3**(1) : 47.

D. 3/13–15 ; P. 19 ; V. 9 ; A. 2/5 ; C. 19 ; L. 1. 40–44.

Max. Size :—450 mm.

Distribution : Found in Punjab, Sind, Cutch, Deccan, South India and Malabar. From Krishna river through Orissa, U. P., Bengal and Burma.

17. Labeo rohita (Hamilton).

1822. *Cyprinus rohita*, Hamilton, *Fish. Ganges*, 301, 388.

1849. *Labeo finbriatus*, Cuvier and Valenciennes, *Hist. Nat. Foissons* **XVI** : 350.

1878. *Labeo rohita*, Day, *Fish. India*, **1** : 538.

1929. *Labeo rohita*, Prasad and Mukerji, *Rec. Indian Mus.*, **31** : 193.

1937. *Labeo rohita*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 57.

1953. *Labeo rohita*, Sinha and Shiromany, *Rec. Indian Mus.*, **51**(1) : 62.

1957. *Labeo rohita*, Moitra, *Uttara Bharati*, **3**(1) : 48.

D. 3/12–13 ; P. 17 ; V. 19 ; A. 2/5 ; C. 19 ; L. 1. 40–42.

Max. Size :—900 mm.

Distribution : Found in Sind, throughout Northern India, Assam and Burma.

18. Labeo gonius (Hamilton).

1822. *Cyprinus gonius*, Hamilton, *Fish. Ganges*, 289, 387.

1849. *Labeo microlepidotus*, Cuvier and Valenciennes, *Hist. Nat. Poissons*, **XVI** : 352.

1878. *Labeo gonius*, Day, *Fish India*, **1** : 537–38.

1937. *Labeo gonius*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 54–55.

1938. *Labeo gonius*, Hora, *Rec. Indian Mus.*, **40**(2) : 176.

1953. *Labeo gonius*, Chauhan and Rama Krishna, *Ibid.*, **51**(3) : 408.

1957. *Labeo gonius*, Moitra, *Uttarati Bharati*, **3**(1) : 47.

D. 2–3/13–14 ; P. 17 ; V. 9 ; A. 2/5 ; C. 19 ; L. 1. 71–84.

Max. Size :—350 mm.

Distribution : Found throughout Northern and Southern Indian rivers upto Krishna river and Burma.

19. Rohtee cotio (Hamilton).

1822. *Cyprinus cotio*, Hamilton, *Fish. Ganges*, 339, 393.

1878. *Rohtee cotio*, Day, *Fish. India*, **1** : 578.

1937. *Rohtee cotio*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 58.

1953. *Rohtee cotio*, Chauhan and Rama Krishna, *Rec. Indian Mus.*, **51**(3) : 108.

1957. *Rohtee cotio*, Moitra, *Uttara Bharati*, **3**(1) : 48.

D. 11–12 (3–4/8.) ; P. 13 ; V. 10 ; A. 29–36 (2–3/27–33) ; C. 19 ; L. 1. 55–70.

Max. Size :—130 mm.

Distribution : Found throughout India, Burma except the Malabar coast and south of Krishna river.

(*iv*) Family—*Cobitidae.*

20. Nemachilus botio (Hamilton).

1822. *Cobitis botio* Hamilton, *Fish. Ganges*, 350, 394.

1878. *Nemachilus botio*, Day, *Fish. India*, **1** : 614.

1937. *Nemachilus botio*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 71.

1953. *Nemachilus botio*, Chauhan and Rama Krishna, *Rec. India Mus.*, **51**(3) : 409.

1957. *Nemachilus botio*, Moitra, *Uttara Bharati*, **3**(1) : 48.

D. 2/10–12 ; P. 11 ; V. 8 ; A. 2/5 ; C. 17.

Max. Size :—80 mm.

Distribution : Found throughout India and Ceylon except Malabar and south of river Krishna.

21. Botia dario (Hamilton).

1822. *Cobitis dario*, Hamilton, *Fish Ganges*, 394.

1870. *Botia dario*, Gunther, *Catol. Fish. Brit. Mus.*, **VII** : 366.

1878. *Botia dario*, Day, *Fish. India*, **1** : 606.

1937. *Botia dario*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.* **3** : 65–66.

D. 3/9–10 ; P. 14 ; V. 8 ; A. 2/5–6 ; C. 19.

Max. Size :—85 mm.

Distribution : Found in Northern India and Assam.

Sub-order (*d*)—Siluroidei.

(*v*) Family—*Claridae.*

22. Clarias batrachus (Linnens).

1822. *Macropterus magur*, Hamilton, *Fish. Ganges*, 146, 374.

1849. *Clarias batrachus*, Cuvier Valenciennes, *Hist. Nat. Poissons* **XV** : 378, 385.

1878. *Clarias magur*, Day, *Fish. India*, **1** : 485.

1937. *Clarias batrachus*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 80.

1953. *Clarias batrachus*, Sinha and Shiromany, *Rec. Indian Mus.*, **51**(1) : 62.

1957. *Clarias batrachus*, Moitra, *Uttara Bharati*, **3**(1) : 48.

D. 62–76 ; P. 1/8–11 ; V. 6 ; A. 45–58 ; C. 15–17.

Max. Size :—360 mm.

Distribution : Found in fresh and brackish waters of the plains of India Burma, Ceylon and the Malaya archipelago.

(*vi*) Family—*Heteropneustidae.*

23. Heteropneustes fossilis (Bloch).

1822. *Silurus singio*, Hamilton, *Fish. Ganges*, 147, 374.

1878. *Saccobranchus fossilis*, Day, *Fish. India*, **1** : 486.

1936. *Heteropneustes fossilis*, Hora, *Rec. India, Mus.*, **38** : 208.

1937. *Heteropneustes fossilis*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 81.

1953. *Heteropneustes fossilis*, Sinha and Shiromany, *Rec. Indian Mus.*, **51**(1) : 63.

1957. *Heteropneustes fossilis*, Moitra, *Uttara Bharati*, **3**(1) : 49.

D. 6–7 ; P. 1/7 ; V. 6 ; A. 60–79 ; C. 19.

Max. Size :—260 mm.

Distribution : Found in the fresh water of Sind, India, Ceylon, Burma and Cochin China.

(*vii*). Family—*Siluridae.*

24. Callichrous pabda (Hamilton).

1822. *Silurus pabda*, Hamilton, *Fish. Ganges*, 150, 375.

1870. *Callichrous pabda*, Gunther, *Catol. Fish. Brit. Mus.*, **V** : 47.

1878. *Callichrous pabda*, Day, *Fish. India*, **1** : 479.

1937. *Callichrous pabda*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 83.

1953. *Callichrous pabda*, Chauhan and Rama Krishna, *Rec. Indian Mus.*, **51**(3) : 410.

1957. *Callichrous pabda*, Moitra, *Uttara Bharati*, **3**(1) : 49.

D. 4–5 ; P. 1/11–13 ; V. 8 ; A. 3/52–58 ; C. 18.

Max. Size :—120 mm.

Distribution : Common in the Indus, Ganges and Bramhaputra rivers as well as Orissa and Darjeeling.

25. Callichrous bimaculatus (Bloch).

1849. *Silurus bimaculatus*, Cuvier and Valenciennes, *Hist. Nat Poissons*, **XV** : 360–365.

1870. *Callichrous bimaculatus*, Gunther, *Catol. Fish. Brit. Mus.*, **V** : 45.

1878. *Callichrous bimaculatus* Day, *Fish. India* **1** : 476–77.

1937. *Callichrous bimaculatus*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 82.

1953. *Callichrous binaculatus* Chauhan and Rama Krishna, *Rec. Indian Mus.*, **51**(3), 410.

1957. *Callichrous bimaculatus* Moitra, *Uttara Bharati*, **3**(1) : 49.

D. 4 ; P. 1/13 ; V. 8 ; A. 2–3/58–72 ; C. 17.

Max. Size :—135 mm.

Distribution : Found in the fresh waters of Sind throughout India, Assam and Ceylon to Malaya archipelago.

26. Wallagonia attu (Bloch).

1870. *Wallago attu*, Gunther, *Catol. Fish. Brit. Mus.*, **V** : 36.

1878. *Wallago attu*, Day, *Fish India*, **1** : 479–80.

1921. *Wallago attu*, Hora, *Rec. Indian Mus.*, **22** : 178.

1937. *Wallago attu*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.* **3** : 84.

1941. *Wallago attu*, Sen, *Ibid.*, **7** : 9.

1952. *Wallago attu*, Menon, *Rec. Indian Mus.*, **50**(2) : 267.

1953. *Wallago attu*, Sinha and Shiromany, *Ibid.*, **51**(1) : 63.

1953. *Wallagonia attu*, Chauhan and Rama Krishna, *Ibid.*, **51**(3) : 410.

1957. *Wallagonia attu*, Moitra, *Uttara Bharati*, **3**(1) : 49.

D. 5 ; P. 1/13–16 ; V. 8–10 ; A. 4/82–89 ; C. 17.

Max. Size :—650 mm.

Distribution : Found throughout India, Ceylon and Burma.

(*viii*) Family—*Schilbeidae.*

27. Pangasius pangasius (Hamilton).

1822. *Pimelodus pangasius*, Hamilton, *Fish. Ganges*, 163, 378.

1878. *Pangasius buchanani*, Day, *Fish. India*, **1** : 470.

1937. *Pangasius pangasius*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 86.

D. 1/7 | 0 ; P. 1/12 ; V. 6 ; A. 31–34 (4–5/27–29) ; C. 10.

Max. Size :—500 mm.

Distribution : Found in the fresh and brackish waters of India, Assam and Burma.

28. Eutropiichthys vacha (Hamilton).

1822. *Pimelodus vacha*, Hamilton, *Fish. Ganges*, 196, 378.

1878. *Eutropiichthys vacha*, Day, *Fish. India*, **1** : 490.

1937. *Eutropiichthys vacha*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 86.

1953. *Eutropiichthys vacha*, Chauhan and Rama Krishna, *Rec. Indian Mus.*, **51**(3) : 410.

1957. *Eutropiichthys vacha*, Moitra, *Uttara Bharati*, **3**(1) : 49.

D. 1/7 | 0 ; P. 1/13–16 ; V. 6 ; A. 3–4/42–47 ; C. 17.

Max. Size :—180 mm.

Distribution : Found in the larger rivers of Sind, Punjab to Bengal and Orissa.

29. Eutropiichthys murius (Hamilton).

1822. *Pimelodus murius*, Hamilton, *Fish. Ganges*, 195, 378.

1868. *Pseudeutropius murius*, Day, *Proc. Zool. Soc.*, 306.

1878. *Pseudeutropius murius*, Day, *Fish. India*, **1** : 472.

1937. *Pseudeutropius murius*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 88.

1937. *Eutropiichthys murius*, Hora, *J. Bombay Nat. Hist. Soc.* **39** : 435.

D. 1/7 | 0 ; P. 1/11 ; V. 6 ; A. 3/35–40 ; C. 17.

Max. Size :—280 mm.

Distribution : Found in the rivers of Sind, Northern India, Orissa and Assam.

30. Silonia silondia (Hamilton).

1822. *Pimelodus silondia*, Hamilton, *Fish. Ganges*, 160, 375.

1858. *Silundia Gangetica*, Blyth, *Proc. Asiat. Soc. Bengal*, 286.

1876. *Silundia Gangetica*, Day, *J. Lin. Soc. Zool.* **12** : 569.

1878. *Silundia Gangetica*, Day, *Fish. India*, **1** : 488.

1937. *Silonia silondia*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 89.

1953. *Silonia silondia*, Sinha and Shiromany, *Rec. Indian Mus.*, **51**(1) : 63.

D. 1/7 | 0 ; P. 1/11–13 ; V. 6 ; A. 4/36–44 ; C. 17.

Max. Size :—350 mm.

Distribution : Found in the estuaries of India and Burma, ascending the larger rivers almost to their sources.

31. Clupisoma garua (Hamilton).

1822 *Silurus garua*, Hamilton, *Fish. Ganges*, 156, 375.

1878. *Pseudeutropius garua*, Day, *Fish. India*, **1** : 474.

1937. *Pseudeutropius garua*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 87.

1953. *Clupisoma garua*, Chauhan and Rama Krishna, *Rec. Indian Mus.*, **51**(3) : 411.

1957. *Clupisoma garua*, Moitra, *Uttara, Bharati*, **3**(1) : 50.

D. 1/7 | 0 ; (in young) ; P. 1/12 ; V. 6 ; A. 3/26–33 ; C. 17.

Max. Size :—250 mm.

Distribution. Found throughout the larger rivers of Sind, India, Assam and Burma.

(*ix*) Family—*Bagridae*.

32. Mystus (*Mystus*) **cavasius** (Hamilton).

1822. *Pimelodus cavasius*, Hamilton, *Fish. Ganges*, 213, 379.

1870. *Macrones cavasius*, Gunther, *Catol. Fish. Brit Mus.*, **V** : 76.

1878. *Macrones cavasius*, Day, *Fish. India*, **1** : 447.

1934. *Mystus cavasius*, Smith, *J. Nat. Hist. Soc. Siam.*, **9** : 294.

1937. *Mystus cavasius*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 91.

1948. *Mystus cavasius*, Hora, *Rec. Indian Mus.*, **XLVI** : 65.

1953. *Mystus cavasius*, Chauhan and Rama Krishna, *Ibid.*, **51**(3) : 411.

1957. *Mystus cavasius*, Moitra, *Uttara Bharati*, **3**(1) : 50.

D. 1/7 | 0 ; P. 1/8 ; V. 6 ; A. 11–13 (4/7–9) ; C. 16.

Max. Size :—170 mm.

Distribution : Throughout India, Assam and Burma.

33. Mystus (*Mystus*) **vittatus** (Bloch.).

1822. *Pimelodus carcio*, Hamilton, *Fish. Ganges*, 181, 377

1878. *Macrones vittatus*, Day, *Fish. India*, 1 : 448.

1936. *Mystus vittatus*, John, *J. Bombay Nat. Hist. Soc.*, **38** : 706.

1937. *Mystus vittatus*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 93.

1948. *Mystus vittatus*, Hora, *Rec. Indian Mus.*, **46** : 70.

1953. *Mystus* (*Mystus*) *vittatus*, Jayaram, *Ibid.*, **51**(4) : 534.

1957. *Mystus vittatus*, Moitra, *Uttara Bharati*, **3**(1) : 50.

D. 1/7 | 0 ; P. 1/9 ; V. 6 ; A. 2–3/7–9 ; C. 17.

Max. Size :—110 mm.

Distribution : Throughout Sind, India, Assam, Burma, Siam and Ceylon.

34. Mystus (*Mystus*) **menoda** (Hamilton),

1822. *Pimelodus menoda*, Hamilton, *Fish. Ganges*, 203, 379.

1858. *Barbus menoda*, Blyth, *Proc. Asiat. Soc. Bengal*, 285.

1878. *Macrones corsula*, Day, *Fish. India*, 1 : 446.

1937. *Mystus menoda*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 92.

1948. *Mystus menoda*, Hora, *Rec. Indian Mus.*, **XLVI** : 65.

1953. *Mystus corsula*, Sinha and Shiromany, *Ibid.*, 51(1) : 64.

1957. *Mystus corsula*, Moitra, *Uttara Bharati*, 3(1) : 50–51.

D. 1/7 | 0 ; P. 1/9 ; V. 6 ; A. 11–13 (3–5/8) ; C. 17.

Max. Size :—240 mm.

Distribution : Found throughout Northern India and Assam.

35. Mystus *Mystus* **bleekeri** (Day).

1878. *Macrones bleekeri*, Day, *Fish. India*, 1 : 451.

1935. *Mystus bleekeri*, Hora and Mukerji, *Rec. Indian Mus.*, **27** : 385.

1937. *Mystus bleekeri*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 91.

1953. *Mystus bleekeri*, Chauhan and Rama Krishna, *Rec. Indian Mus.*, 51(3) : 411.

D. 1/7 | 0 ; P. 1/9–10 ; V. 6 ; A. 9–10 (3/6–7) ; C. 17.

Max. Size :—90 mm.

Distribution : Found in Sind, Northern India and Burma.

36. Mystus (*Osteobagrus*) **seenghala** (Sykes).

1841. *Platystomus seenghala*, Sykes, *Trans. Zool. Soc.*, **II** : 371.

1858. *Bargus aorellus*, Blyth, *Proc. Asiat. Soc Bengal*, **2** : 83.

1878. *Macrones seenghala*, Day, *Fish. India*, 1 : 444.

1937. *Mystus seenghala*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 93.

1953. *Mystus seenghala*, Chauhan and Rama Krishna, *Rec. Indian Mus.*, 51(3) : 411.

1957. *Mystus seenghala*, Moitra, *Uttara Bharati*, 3(1) : 50.

D. 1/7 | 0 ; P. 1/9 ; V. 6 ; A. 11–12 (3/8–9) ; C. 19–21.

Max. Size :—475 mm.

Distribution : Found throughout India.

37. Mystus (*Osteobagrus*) **aor** (Hamilton).

1822. *Pimelodus aor*, Hamilton, *Fish. Ganges*, 205, 379.

1878. *Macrones aor*, Day, *Fish. India*, 1 : 444.

1937. *Mystus aor*, Hora, *Rec. Indian Mus.*, **39** : 19.

1948. *Mystus aor*, Hora, *Ibid.*, **XLVI** : 72.

1953. *Mystus aor*, Sinha and Shiromany, *Ibid.*, 51(1) : 63.

1953. *Mystus* (*Osteobagrus*) *aor*, Jayaram, *Ibid.*, 51(4) : 549.

D. 1/9 ; P. 1/7–10 ; V. 6 ; A. 12–13 (3–4/8–9) ; C. 17.

Max. Size :—100 mm.

Distribution : Throughout Sind, Punjab, Delhi, U. P., Assam and Burma.

38. **Rita rita** (Hamilton).

1822. *Pimelodus rita*, Hamilton, *Fish. Ganges*, 165, 376.
1878. *Rita Buchanani*, Day, *Fish. India*, **1** : 454.
1937. *Rita rita*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 95.
1948. *Rita rita*, Hora, *Rec. Indian Mus.*, **46** : 68.
1953. *Rita rita*, Sinha and Shiromany, *Ibid.*, **51**(1) : 63.
1957. *Rita rita*, Moitra, *Uttara Bharati*, **3**(1) : 51.

D. 1/6 | 0 ; P. 1/10 ; V. 8 ; A. 4/10 (4–5/9–Day) ; C. 19.

Max. Size :—460 mm.

Distribution : In the larger rivers of India.

(*x*) Family—*Sisoridae.*

39. **Bagarius bagarius** (Hamilton).

1822. *Pimelodus bagarius*, Hamilton, *Fish. Ganges*, 186, 378.
1870. *Bagarius varelli*, Gunther, *Catol. Fish. Brit. Mus.*, **V** : 183.
1878. *Bagarius varelli*, Day, *Fish. India*, 1 : 495.
1937. *Bagarius bagarius*, Shaw and Shebbeare, *J. Asiat Soc. Bengal Sci.*, **3** : 97.
1953. *Bagarius bagarius*, Sinha and Shiromany, *Rec. Indian Mus.*, **51**(1) : 63.
1957. *Bagarius bagarius*, Moitra, *Uttara Bharati*, **3**(1) : 51.

D. 1/6 | 0 ; P. 1/12 ; V. 6 ; A. 3/10–12 ; C. 17.

Max. Size :—850 mm.

Distribution : Found in the larger rivers and their estuaries in India and Java.

III. Order—Beloniformes.

(*xi*) Family—*Xenentodontidae.*

40. **Xenentodon cancilla** (Hamilton).

1822. *Esox cancilla*, Hamilton, *Fish. Ganges*, 213, 380.
1878. *Belone cancilla*, Day, *Fish. India*, 1 : 511.
1937. *Xenentodon cancilla*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 108.
1941. *Xenentodon cancilla*, Hora, *Rec. Indian Mus.*, **43** : 256.
1953. *Xenentodon cancilla*, Chauhan and Rama Krishna, *Ibid.* **51**(3) : 412.
1957. *Xenentodon cancilla*, Moitra, *Uttara Bharati*, **3**(1) : 51.

D. 2/15 ; P. 1/8/1 ; V. 1/5 ; A. 2/16 ; C. 15.

Max. Size :—250 mm.

Distribution : Widely distributed in the fresh waters of India, Ceylon and Burma.

IV. Order—Ophiocephaliformes.

(*xii*) Family—*Ophiocephalidae.*

41. Channa striatus (Bloch).

1822. *Ophiocephalus wrahl*, Hamilton, *Fish. Ganges*, **60** : 367.

1878. *Ophiocephalus striatus*, Day, *Fish. India*, 1 : 336.

1937. *Ophicephalus striatus*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 124.

1952. *Channa striatus*, Menon, *Rec. Indian Mus.*, **50** : 270.

1953. *Channa striatus*, Chauhan and Rama Krishna, *Ibid.*, **51**(3) : 415.

1957. *Channa striatus*, Moitra, *Uttara Bharati*, **3**(1) : 52.

D. 37–45 ; P. 17 ; V. 6 ; A. 23–26 ; C. 13 ; L. 1 50–59.

Max. Size :—280 mm.

Distribution : Found in the swamps, grassy tanks and fresh waters throughout the plains of India, Ceylon, Burma, China and the Philippines.

42. Channa punctatus (Bloch).

1822. *Ophiocephalus lata*, Hamilton, *Fish. Ganges*, **63** : 637.

1878. *Ophiocephalus punctatus*, Day, *Fish. India*, 1 : 367–68.

1937. *Ophicephalus punctatus*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 123.

1953. *Channa punctatus*, Chauhan and Rama Krishna, *Rec. Indian Mus.*, **51**(3) : 415.

1957. *Channa punctatus*, Moitra, *Uttara, Bharati*, **3**(1) : 52.

D. 30 ; P. 2/15 ; V. 1/15 ; A. 21-23 ; C. 12 ; L. 1. 37–40.

Max. Size :—180 mm.

Distribution : Found in fresh waters in the plains of India, stagnent waters prefered.

43. Channa gachua (Hamilton).

1822. *Ophiocephalus gachua*, Hamilton, *Fish. Ganges*, **68** : 367.

1878. *Ophiocephalus gachua*, Day, *Fish. India*, 1 : 367.

1937. *Ophicephalus gachua*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 121–22.

1952. *Channa gachua*, Menon, *Rec. Indian Mus.*, **50** : 270.

1953. *Channa gachua*, Chauhan and Rama Krishna, *Ibid.*, **51**(3) : 414.

D. 32–37 ; P. 15 ; V. 6 ; A. 21–23 ; C. 12 ; L. 1. 40–45.

Max. Size :—210 mm.

Distribution : Found in fresh waters of India, Ceylon, Burma and Andmans.

44. Channa stewartii (Playfair).

1867. *Ophiocephalus stewartii*, Playfair, *Proc. Zool. Soc.*, 14.

1878. *Ophiocephalus stewartii*, Day, *Fish. India*, 1 : 367.

1937. *Ophicephalus stewartii*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 123.

D. 39–40 ; P. 17 ; V. 6 ; A. 27 ; C. 14 ; L. 1. 45–50.

Max. Size :—380 mm.

Distribution : According to Day, it is found in both running and standing waters of Cachar and Assam. Shaw and Shebbeare reported from the clear streams in the forest of Duars. This is now recorded for the first time from Kanpur (Uttar Pradesh).

V. Order—Perceformes.

Sub-order (*e*)—Percoidei.

(*xiii*) Family—*Centropomidae.*

45. Ambassis nama (Hamilton).

1822. *Chanda nama*, Hamilton, *Fish. Ganges*, 109, 371.

1878. *Ambassis nama*, Day, *Fish. India*, 1 : 50–51.

1937. *Ambassis nama*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 110–11.

1938. *Ambassis nama*, Hora, *Rec. Indian Mus.*, **40**(2) : 181.

1953. *Ambassis nama*, Chauhan and Rama Krishna, *Ibid.*, **51**(3) : 413.

1957. *Ambassis nama*, Moitra, *Uttara Bharati*, 3(1) : 52.

D. 7 | 1/13–17 : P. 13 ; V. 1/5 ; A. 3/14–17 ; C. 17.

Max. Size :—65 mm.

Distribution : Common throughout India and Burma.

46. Ambassis ranga (Hamilton).

1822. *Chanda ranga*, Hamilton, *Fish. Ganges*, 113, 371.

1860. *Ambassis ranga*, Blyth, *Proc. Asiat. Soc. Bengal*, 138.

1878. *Ambassis ranga*, Day, *Fish. India*, 1 : 51.

1937. *Ambassis ranga*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 111.

1938. *Ambassis ranga*, Hora, *Rec. Indian Mus.*, **40**(2) : 181.

1952. *Ambassis ranga*, Menon, *Ibid.*, **50** : 270.

1953. *Ambassis ranga*, Chauhan and Rama Krishna, *Ibid.*, **51**(3) : 413.

1957. *Ambassis ranga*, Moitra, *Uttara Bharati*, **3**(1) : 52.

D. 7 | 1/13–15 ; P. 11 ; V. 1/5 ; A. 3/14–16 ; C. 17 ; L. r. 60–70.

Max. Size :—50 mm.

Distribution : Throughout India and Burma.

(*xiv*) Family—*Sciaenidae.*

47. Sciaena coiter (Hamilton).

1822. *Bola coiter*, Hamilton, *Fish. Ganges*, 75, 368.

1860. *Johnius coiter*, Blyth, *J. Asiat. Soc. Bengal*, 141.

1878. *Sciaena coiter*, Day, *Fish. India*, 1 : 187.

1937. *Sciaena coiter*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 115–16.

D. 10 | 1–2/26–29 ; P. 17 ; V. 1/5 ; A. 2/7 ; C. 17 : L. 1. 50–55.

Max. Size :—190 mm.

Distribution ; Throughout the larger rivers of India,

(*xv*) Family—*Nandidae.*

48. Nandus nandus (Hamilton).

1822. *Coius nandus*, Hamilton, *Fish. Ganges*, 96, 370.

1849. *Nandus marmoratus*, Cuvier and Valenciennes, *Hist. Nat. Poissons*. **VII** : 482.

1878. *Nandus marmoratus*, Day, *Fish. India*, 1 : 129.

1937. *Nandus nandus*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 115.

1938. *Nandus nandus*, Hora, *Rec. Indian Mus.*, **40**(2) : 181.

1953. *Nandus nandus*, Chauhan and Krishna, *Ibid.*, **51**(3) : 413.

1957. *Nandus nandus*, Moitra, *Uttara Bharati*, **3**(1) : 53.

D. 13/1/11/1 ; P. 2/11/3 ; V. 1/7 ; A. 3/7 ; C. 14 ; L. 1. 46–57.

Max. Size :—160 mm.

Distribution : Found in the muddy streams, ponds, ditches and inundated fields of India and Burma.

Sub-order (*f*)—Anabantoidei,

(*xvi*) Family—*Osphronemidae.*

49. Colisa fasciatus (Bloch).

1822. *Trichopodus colisa*, Hamilton, *Fish. Ganges*, 117, 120.

1869. *Trichogaster fasciatus*, Day, *Proc. Zool. Soc.* 520.

1878. *Trichogaster fasciatus*, Day, *Fish. India*, 1 : 374.

1937. *Trichogaster fasciatus*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 117.

1952. *Colisa fasciatus*, Menon, *Rec Indian Mus.*, **50**(2) : 270.

1957. *Colisa fasciatus*, Moitra, *Uttara Bharati*, 3(1) : 53.

D. 15–17/9–13 ; P. 10 ; V. 1 ; A. 15–18/14–19 ; C. 15 ; L. 1. 29–31.

Max. Size :—96 mm.

Distribution : Found in the fresh waters and estuaries of river Ganges in India and Burma.

Sub-order (*g*)—Goboidei.

(*xvii*) Family—*Gobiidae.*

50. Glossogobius giuris (Hamilton).

1822. *Gobius guiris*, Hamilton, *Fish. Ganges*, 51, 366.

1878. *Gobius guiris*, Day, *Fish. India*, 1 : 294–95.

1937. *Glossogobius guiris*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 114.

1938. *Glossogobius guiris*, Hora, *Rec. Indian Mus.*, **40**(2) : 181.

1953. *Glossogobius guiris*, Chauhan and Rama Krishna, *Ibid.*, **5**5(3) : 414.

1957. *Glossogobius guiris*, Moitra, *Uttara Bharati*, **3**(1) : 53.

D. 6–1/11 ; P. 3/15/2 ; V. 1/5 ; A. 2/8 ; C. 14 ; L. 1. 35–40.

Max. Size :—410 mm.

Dsitribution : Common throughout India.

VI. Order—Mastacembeliformes.

(*xviii*) Family—Mastacembelidae.

51. **Mastacembelus armatus** (Lacepede).

1822. *Macrognathus armatus*, Hamilton, *Fish. Ganges*, 28, 364.

1841. *Mastacembelus armatus*, Sykes, *Trans. Zool. Soc.* **II** : 350.

1878. *Mastacembelus armatus*, Day, *Fish. India*, 1 : 340.

1937. *Mastacembelus armatus*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 126.

1941. *Mastacembelus armatus*, Hora, *Rec. Indian Mus.*, **43** : 256.

1953. *Mastacembelus armatus*, Chauhan and Rama Krishna *Ibid.*. **51**(3) : 416.

1957. *Mastacembelus armatus*, Moitra, *Uttara Bharati*, **3**(1) : 53.

D. 32–39/74–90 ; P. 23 ; A. 3/75–88.

Max. Size :—780 mm,

Distribution : Common throughout India, Burma and China.

52. **Mastacembelus pancalus** (Hamilton).

1822. *Macrognathus pancalus*, Hamilton, *Fish. Ganges*, 30, 364.

1849. *Mastacembelus pancalus*, Cuvier and Valenciennes, *Hish. Nat. Poissons*, **VIII** : 455.

1878. *Mastacembelus pancalus*, Day, *Fish. India*, 1 : 340.

1937. *Mastacembelus pancalus*, Shaw and Shebbeare, *J. Asiat. Soc. Bengal Sci.*, **3** : 126.

1953. *Mastacembelus pancalus*, Chauhan and Rama Krishna, *Rec. Indian Mus.*, **51**(3) : 416.

1957. *Mastacembelus pancalus*, Moitra, *Uattra Bharati*, **3**(1) : 54.

D. 20/2/48 ; P. 2/19 ; A. 3/40 ; C. 13.

Max. Size :—194 mm.

Distribution : Found in the large rivers of India and localities near the sea.

A SYSTEMATIC ACCOUNT OF THE FRESH-WATER DIATOMS OF UTTAR PRADESH—I

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INTRODUCTION

There are a few accounts dealing with the systematics of fresh-water diatoms from India. Recently Venkataraman (1939, 1956), Krishnamurthy (1954) and Gandhi (1955, 1956, 1957, 1958 *a*, *b*, 1959) have contributed systematic accounts of fresh-water diatoms of South India, Dharwar, Kolhapur, Sagar and Bombay. Abdul Majeed (1935) has described the Bacillariophyta of the Punjab. Thus, nothing has so far been published on the diatoms found in Uttar Pradesh. Pending ecological and culture investigations, this paper deals with systematic enumeration of the diatom—flora of a permanent pond, belonging to Deoria district, U. P.

MATERIAS AND METHODS

(*a*) *Materials* :—The materials for the present investigation were collected monthly from July 1959 to February 1960, by the author from a permanent pond in the village Phulwaria, near Bhatpar Rani railway station (N. E. Rly.) in Deoria district. The pond is shallow and about 250 metres long and 100 metres broad with the maximum depth of water upto 2 to 3 metres in July to September.

The pond is kept clean of all vegetation save the micro-phytoplankton. During the rainy season and even upto November the margins of the pond are covered with *Azolla pinnata* and *Lemna* sp. The marginal rooted flora at localised palces consists of small colonies of *Nymphaea stellata* Isolated individvals of *Aponogeton* sp. occur in clear water with mud in the bottom. The eastern part of the pond has a sandy bed and remains free of any rooted hydrophyte. The muddy margins are covered with dense growth of *Eleocharis plantaginea.*

The species collected in the winter months from the surrounding marshy area are as follows :—*Alternanthera sessilis*, *Oldenlandia dichotoma*, *Sporobolus* sp. *Polygonum plebejum*, *Gnaphalium luteo-album*, *Cynodon dactylon* with long internodes. The submerged species *viz. Ipomoea reptans*, *Glossostigma spanthulatum*, *Vallisneria* sp. *Eleocharis plantaginea*, *Limnanthemum indicum*, *Spirogyra* sp. and *Hydrilla verticillata* are abundant.

The collections of the diatoms were made from three zones *viz.* (*i*) margin, (*ii*) centre and (*iii*) intermediate region of the pond. Because of the shallow depth and clear water the light condition is favourable at all depths for growth of a good population of diatoms.

(*b*) *Methods* : - Pond water is taken in a test-tube and conc. HNO_3 is added in drops. The mixture is thereafter heated gradually for 2 minutes after which the supernatant liquid is decanted and the residue is made acid free by repeated process of washing with distilled water, centrifuging and then decantation. A drop of the acid fee residue is dried on a slide smeared with Mayer's albumin.

The slide is than passed through 90%–100% alcohol and then xylol and the preparation is finally mounted in Canada Balsam or styrax.

In all 32 forms are described, representing 12 genera. Of these 32 forms there are 6 new forms.

The species are classified according to the scheme given by Hustedt (1930).

A SYSTEMATIC ENUMERATION OF THE DIATOMS
BACILLARIOPHYTA (Diatomeae)

A.	Order	...	CENTRALES
	Sub-order	...	DISCINEAE
	Family	...	Coscinodiscaceae
	Sub-family	...	Coscinodiscoideae
	Genus	...	CYCLOTELLA Kützing 1834

1. *Cyclotella operculata* (Ag.) Kütz. (Fig. 1).

Kützing, Syn. Diat. S. 7. (1834), Bac. S. 50, Taf. 1, Fig. 1 e. p (1844) ; Hustedt, Fr., Pascher's Süsswasser—Flora, Heft 10, 1930, p. 102 fig. 66.

Valves depressed in the middle. Striae obscure, very short upto the middle of the radius, strong, tangential, wavy and wider in the periphery. In the middle of the two striae forming knob. The middle portion approximately very tender and exhausted at point.

Dimention :—Diameter–6 to 8μ and striations–14 to 16 in 10μ.

The species agrees with the type quite well. The form was rare in the collections.

B.	Order	...	PENNALES
	Sub-order	...	ARAPHIDINEAE
	Family	...	Fragilariaceae
	Sub-family	...	Fragilarioideae
	Genus	...	FRAGILARIA Lyngbye 1819

2. *Fragilaria capucina* Desm. var. *lanceolata* Grun. (Fig. 2).

Hustedt, Fr., Pascher's Süsswasser Flora, Heft 10, 1930, p. 138, fig. 127.

Frustules in the girdle-view linear, rectangular united together to form band. Valves linear-lanceolate with slightly constricted rounded ends. Striae thin and short. Striae absent in the middle and the walls slightly depressed inwards.

Dimensions :—Length—24·5 to 25·5μ, breadth—3·5μ and striations—15 to 16 in 10μ.

The diatom resembles the type and the only difference is slight depression in the middle.

3. *Fragilaria crotonensis* Kitton (Fig. 3).

Length:—70·5 to 75μ, breadth 3 to 3·5μ and striations 17 to 19 in 10μ.

4. *Fragilaria intermida* Grunow (Figs. 4 and 5).

Length :—72·5 to 80μ, breadth—5·5 to 6μ and striations 19 to 12 in 10μ.

	Genus	...	SYNEDRA Ehrenberg 1830

5. *Synedra gaillonii* (Bory) Ehr. var. ***longipes*** var. nov. (Fig. 6).

Frusltula aspectu zonali linearia. Valvulae 320·5 to 344·5μ longae, 7·5 to 8μ latae, lineari—ellipticae, parietibus fere parallelis usque ad apices; apices rotundati. Pseudoraphe angusta, linearis. Striae 9 to 10 in 10μ, asperae, delicatulae et parallelae.

Frustules in the girdle-view linear. Valves linear elliptical, almost parallel walls till the ends; ends rounded. Pseudoraphe narrow, linear. Striae coarse delicate and parallel.

Dimensions :—Length—320·5 to 344·5μ, breadth—7·5 to 8μ and striations—9 to 10 in 10.

This form shows resemblance to *Synedra gaillonii* (Bory) Ehr. (Hustedt, Fr., Pascher's Süsswasser Flora, Heft 10, 1930, p. 162, Fig. 197) in the breadth, in the nature and number of striae. But this form differs in the length and is very much longer. Therefore, this form may be considered as a new variety.

6. *Synedra unla* (Nitz.) Ehr. var. ***oxyrhynchus*** (Kütz.) van Heurck. (Fig. 7).

Length :—56·5 to 60, breadth 3·5 to 4μ and striations—14 to 15 in 10μ.

Sub-order	...	BIRAPHIDINEAE
Family	...	Naviculaceae
Sub-family	...	Naviculoideae
Genus	...	PLEUROSIGMA W. Smith 1852

7. *Pleurosigma salinarum* Grunow (Figs. 8 and 9).

Hustedt, Fr., Pascher's Süsswasser Flora, Heft 10, 1930. p. 228, fig. 344.

Valves linear lanceolate, slightly sigmoid rounded ends. Central raphe less sigmoid. Central nodule elongated. The transverse and longitudinal striae very faint, with additional undulated marginal band present.

Dimensions :—Length—90 to 99μ, breadth—14 to 15μ trans. striations—25 in 10μ and oblique striations 26 to 27 in 10.

This form agrees in all respects, only the raphe is bent forming hook likes structure at both the ends.

Genus ... CALONEIS Cleve 1894

8. *Caloneis schumanniana* (Grun.) Cleve var. ***biconstricta*** Grun. (Fig. 38).

Length—30 to 36μ, breadth—6 to 8μ and striations—20 to 22 in 10μ.

9. *Caploneis silicula* (Ehr.) Cleve var. ***alpina*** Cleve (Fig. 10).

Length—33 to 35·5μ, breadth—6·5 to 7·5μ and striations 16 to 20 in 10μ.

Genus ... DIPLONEIS Ehrnberg, 1840

10. *Diploneis subovalis* Cleve (Fig. 11).

Length—34 to 36μ, breadth—15 to 21μ and striations—12 to 14 in 10μ.

11. *Diploneis subovalis* Cleve var. ***cuspidatum*** var. nov. (Fig. 12).

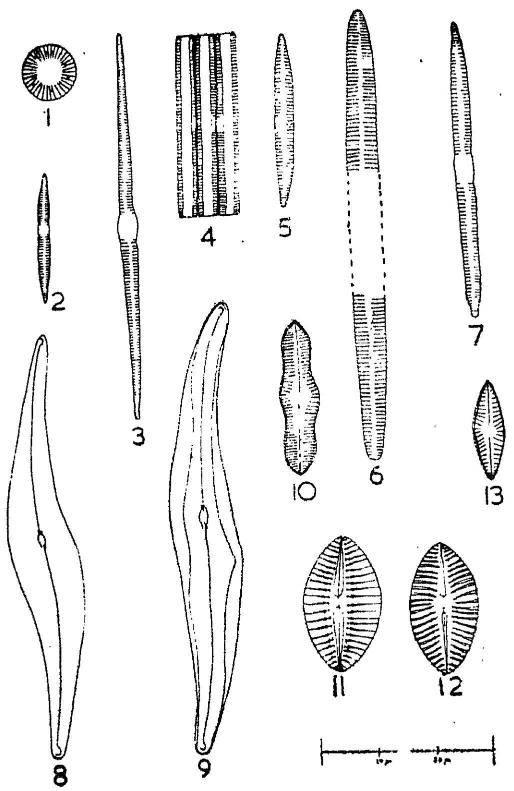
Valvulae 26 to 28μ longae, 15·5 to 17μ latae, ellipticae. apicibus latis rotundatis, lateribus convexis; nodulus centralis amplus, rotundatus; sulcus angustus, ercte appositus nodulo centrali eiusque cornubus. Striae 10 to 11 in 10μ, validae, eminentes, radiales et punctatae, singulae ornatae apice acuto ad latus raphes,

Valves elliptical with broad rounded ends and convex sides. Central nudule large, rounded. Furrow narrow; closely following the central nodule and its horns. Striae strong, prominent and punctate.

Dimensions :—Length—26 to 28μ, and breadth—15·5 to 17μ and striations—10 to 11 in 10μ.

This form closely agrees with *Diploneis subovalis* Cleve (Venkataraman, G., *Pro. Ind. Acad. Sci.*, **X** (6) : pp. 322–23, 1939, pl. XVII, figs. 3 and 4, 47) in details of outline and size. It differs markedly from the type species in having prominent radial striae in the middle and convergent towards the ends. The ends of the striae pointed in contrast to the capitate ends of the type species. Central nodule perfectly rounded. These differences are much marked and deserve varietal importance. A new variety, therefore, is being proposed.

Genus ... NAVICULA Bory 1822



12. *Navicula cinata* (Ehr.) Kütz. var. *heufleri* Grun. (Fig. 13).

Length—18·5 to 20μ, breadth—5 to 6μ and striations—10 in 10μ.

13. *Navicula cocconeiformis* Greg. var. *bifurcata* var. nov. (Fig. 14).

Valvulae 26·5—28μ longae, 7·65–8μ latae, oblongo-ellipticae ; raphe valida et recta, poro centrali distincte bifarcato. Area axialis angusta, centralis vero latior. Striae 22–24 in 10μ, tenues, radiales, mediae vero breviores.

Valves oblong-elliptical. Raphe strong and straight with central pore distinctly bifurcated. Axial area narrow, central area wider. Striae fine radial throughout and the middle striae shortor.

Dimensions :—Length—26·5 to 28μ, and breadth—7 65 to 8.μ and striations—22 to 24 in 10μ.

This diatom differs from *Navicula cocconeiformis* Greg. (Hustedt, Fr. Pascher's Susswasser Flora, Heft 10, 1930, p. 290, fig. 493) in having oblong-elliptical outline, and the arrangement of the middle striae are not similar but smallest in the middle and gradually bigger towards the ends forming slightly bigger central aperture. The important difference in the raphe of the present species having central pores distinctly bifurcated. It is, hence, considered to be its new variety.

14. *Navicula cryptocephala* Kützing. (Fig. 15).

Length—22·5 to 30μ, breadth—6·2 to 7μ and striations—17 to 18 in 10μ.

15. *Navicula digitoradiata* (Greg.) A. Schmidt var. *rotindus* var. nov. (Fig. 16).

Valvulae 52—55μ longae, 12·25—13·5μ latae, lanceolatae apicibus aliquantum contrictis rotundatis. Arae axialis angusta, centralis vero transverse lata. Raphe tenuis et recta, poris centralibus directis in unum, fissuris terminalibus curvatis. Striae 8–10 in 10μ radiales et ad apices parallelae.

Valves lanceolate with somewhat constricted, produced rounded ends. Axial area narrow, central area transversely widened, and terminal—fissures curved. Striae radial and parallel at the ends.

Dimensions :—Length—52 to 55μ, breadth 12·25 to 13·5μ and striations—8 to 10 in 10μ.

The species differs from *Navicula digitoradiata* (Greg.) A. Schmidt (Hustedt, Fr., Pascher'r Süsswasser Flora, Heft 10, 1930, p. 301, fig. 518) in having constricted produced rounded ends and in the middle alternate shorter and longer striae absent. In the present species the middle portion is wider due to the smallest in the middle and bigger on both the sides. It is, therefore, considered to be a new variety.

16. *Navicula halophila* (Grun.) Cleve. (Fig. 17).

Hustedt, Fr., Pascher's Süsswasser Flora, Heft 10, 1930, pp. 268–69, fig. 436.

Valves lanceolate with slightly produced capitate ends. Axial area narrow, linear, central area slightly widened. Raphe straight. Striae parallel and slightly convergent at the ends.

Dimensions :—Length—19·5 to 28μ, breadth—8 to 9μ and striations—15 to 16 in 10μ.

The range in the length of the diatom given in the literature is 32 to 40μ. The specimen from this pond ranges from 19·5 to 28μ. The minimum length recorded from this pond is 19·5μ, is lower than the minimum recorded previously for the type.

17. *Navicula laterostrata* Hustedt. (Fig. 18).

Length—16·75 to 18μ, breadth—6·25 to 7·5μ and striations—15 to 16 in 10μ.

This form is slightly smaller than the type described in literature. The striae is very delicate and were seen only with difficulty.

18. *Navicula salinarum* Grun. var. *intermedia* (Grun.) Cleve. (Fig. 19).

Length—25 to 30μ, breadth—7 to 8μ and striationss—14 to 16 in 10μ.

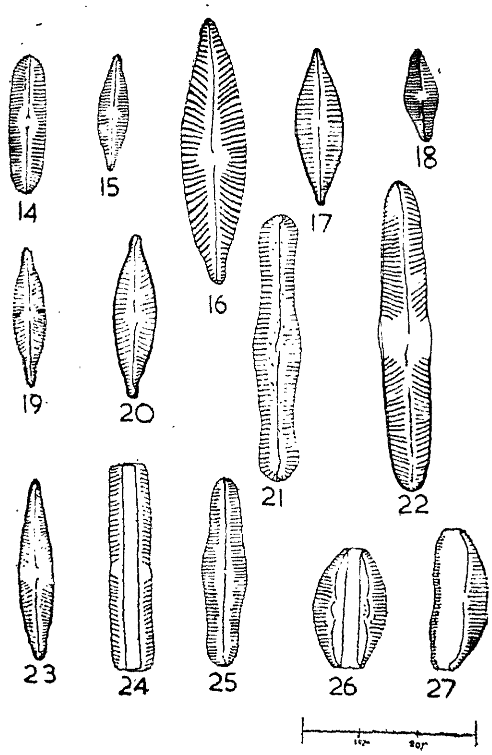
19. *Navicula viridula* Kütz. var. *capitata* Mayer (Fig. 20).

Length—31·5 to to 33·5μ, breadth—7·5 to 9μ and striations—13 to 14 in 10μ,

Genus ... PINNULARIA Ehrenberg 1843

20. *Pinnularia acrosphaeria* (Breb.) W. Smith for. *undulata* Cleve. (Fig. 21).

Length—52 25 to 55·5μ, breadth—9·5 to 10μ and striations—12 in 10μ.



21. *Pinnularia gibba* Ehr. var. nov. *erectus* var. nor. (Fig. 22).

Valvulae 56·5–60μ longae, 9–10μ latae, lineares marginibus rectis et gradatim fastigatae ex medio in apices subcapitatos. Apices rotundati. Valvulae ad apices valde modice angustae evadunt. Raphe tenuis, recta, poro centrali in unum directo. Striae 10–12 in 10μ, radiales in medio, convergentes ad apices. Striae interruptae in parte media.

Valves linear with straight margins and gradually tapering from the middle towards the subcapitate ends. Ends rounded. A very slight decrease in the breadth of the valve towards the ends. Raphe thin, straight and central pore in one direction. Striae radial in the middle and convergent at the ends. Striae interrupted at the middle portion.

Dimensions :—Length—56·5 to 60μ, breadth—9 to 10μ and striations—10 to 12 in 10μ.

This form resembles with *Pinnularia gibba* Ehr. var. *subundulata* Mayer (Hustedt, Fr., Pascher's Süsswasser Flora, Heft 10, 1930, p. 327, fig. 601) but differs from it in the margins straight and the ends of the valves being not wedge-shaped but rounded. Again it is smaller variety then *P. gibba*. It is, hence, suggested to be the new variety.

22. *Pinnularia interrupta* W. Smith. (Fig. 23).

Length—33·5 to 30 μ, breadth—5 to 6μ, and striations—15 to 16 in 10μ.

This form comes very near to *Pinnularia interrupta* var. *subcapitata*, but differs from it in its ends being not so capitat as in the type variety, but having somewhat rounded ends, and the striae are more closer.

23. *Pinnularia viridis* (Nitz.) Ehrenberg. (Figs. 24 and 25).

Length—40 to 60μ, breadth—7·5 to 9·5μ and striations—13 to 15 in 10μ

24. *Pinnularia viridis* (Nitz.) Ehr. var. *turgidus* var. nov. (Figs. 28 and 29).

Frustula linearia et rectangularia aspectu zonali ; valvulae 67·5—72μ longae 20 to 23μ latae, lineares marginibus paulum convexis, apicibus rotundatis. Raphe tenuis et recta. Area axialis angusta, latior in medio. In area centrali raphe crassa evadit in utroque latere. Striae 9 to 10 in 10μ, asperae, paulum radiales in medio et parallelae ad apices. Fascia centralis adest.

Frustules linear and rectangular in girdle-view. Valves linear with slightly convex margins and rounded ends. Raphe thick and straight. Axial area narrow wider in the middle. In the central area the raphe becomes thick from both the sides. Striae coarse, slightly radial in the middle and parallel towards the ends. The longitudinal band is present.

Dimensions :—Length—67·5 to 72μ, breadth—20 to 23μ and striations—9 to 10 in 10μ.

This form in outline resembles *Pinnularia viridis* (Nitz.) Ehr. var. *sudetica* (Hilse) Hust. (Hustedt, Fr., Pascher's Süsswasser Flora, Heft 10, 1930, pp. 334–35, fig. 617*b*) but differs very much in the arrangement of striae and raphe. Striae are parallel towards the poles and raphe forms thick structure in the central pore. A very characteristic longitudinal double band is present. It is, therefore, regarded as a new variety.

Sub-family ... Gomphocymbelloideae

Genus ... AMPHORA Ehrenberg 1840

25. *Amphora ovalis* Kützing. (Figs. 26 and 27).

Length—24 to 26μ, breadth—5 to 7μ and striations—14 to 16 in 10μ.

Genus ... CYMBELLA Agadh 1830

26. *Cymbella turgida* (Greg.) Cleve. (Fig. 30).

Length—35 to 40μ, breadth—9 to to 10μ and striations—10 to 12 in 10μ.

The number of striae is more as given in the literature.

27. *Cymbella ventricosa* Kützing. (Fig. 31).

Length—18·25 to 20μ, breadth—7·5 to 8·5μ and striations—16 to 17 in 10μ.

Genus ... GOMPHONEMA Agrdh 1834

28. *Gomphonema intricatum* Kütz. var. *pumila* Grun.

Length—45 to 55μ, breadth—6 to 9μ and striations—8 to 9 in the middle and 11 to 1? at the ends in 10μ.

29. *Gomphonema gracile* Ehrenberg. (Fig. 34).

Length—62·5 to 71μ, breadth—12·25 to 13·5μ and striations—12 to 13 in 10μ. Striae are parallel.

30. *Gomphonema olivaceum* (Lyng.) Kutzing. (Fig. 35).

Length—30 to 40μ, breadth—6 to 7·5μ and striations—8 to 10 in 10μ.

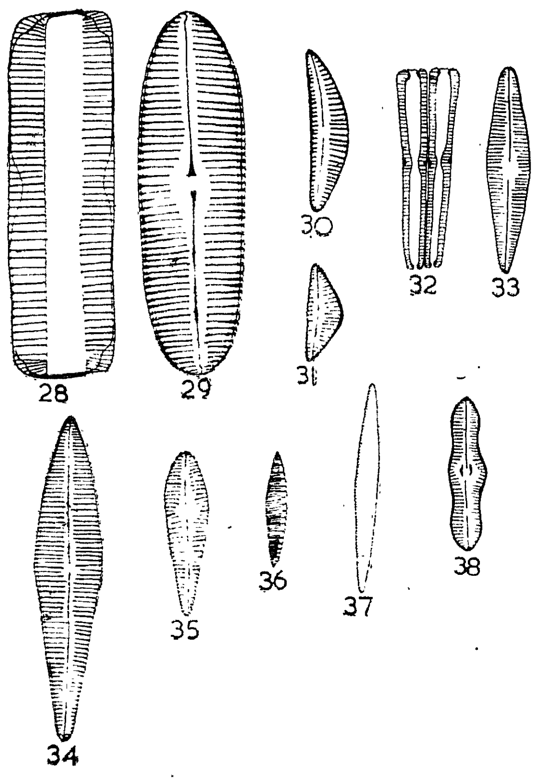
Family	...	Nitzschiaceae
Sub-family	...	Nitzschioideae
Genus	...	NITZSCHIA Hassal 1845

31. *Nitzschia frustulum* (Kütz.) Grun. Var. *perpusilla* (Rab.) Grun. (Fig. 36).

Length—22 to 24μ, breadth—3·5 to 4μ, striations—23 to 24 and keel punctae 9 to 10 in 10μ.

32. *Nitzschia gracilis* Hantzsch. (Fig. 37).

Length—38·5 to 108μ, breadth—3·5 to 4μ and keel punctae 12 to 17 in 10μ, Striae very fine and indistinct.



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A NEW ISOLATE OF *TRICHURUS* FROM INDIA

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The genus *Trichurus* Clem. and Shear, a member of the order Moniliales, is characterized by the presence of long, clavate or expanded fruit bodies (spore bearing portions or *capitulla*) which are beset with long simple or branched hair or spine like appendages (setae). Only four species of this genus are known, *viz.*, *T. cylindricus* Clem. and Shear (Saccardo, 1884–1926), *T. spiralis* Hasselbring (Hasselbring, 1900), *T. gorgonifer* Bainier (Saccardo, 1884–1926) and *T. terrophilus* Swift and Povah (Swift, 1929). Two of the characters of this genus, *viz.*, form and branching of the appendages of the sporiferous head and size and shape of the spores have been emphasized in distinguishing the above four species.

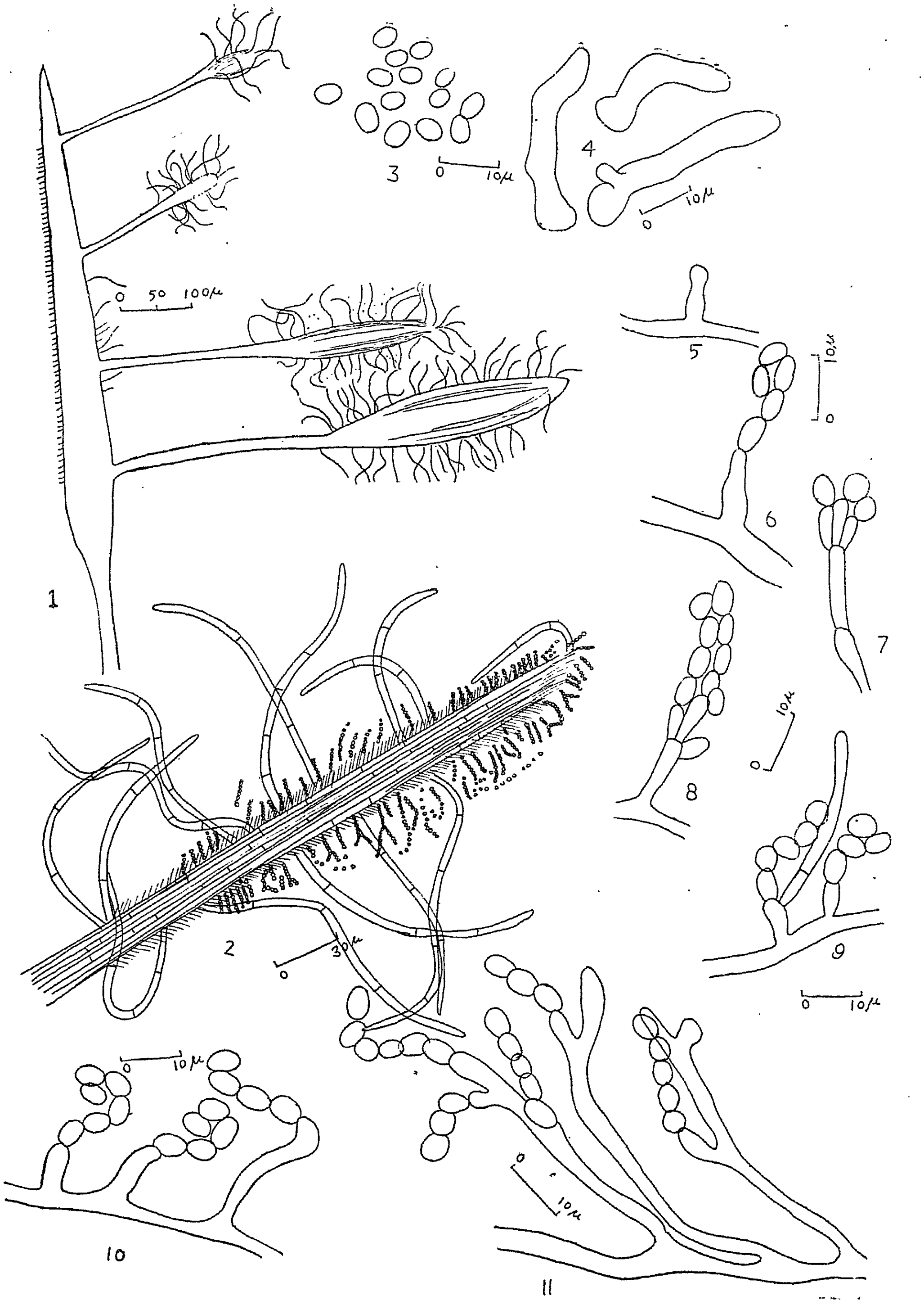
The genus *Trichurus* has not so far been reported from India. Recently the authors isolated a species of *Trichurus* from decaying twigs which resembled with *T. spiralis* in the presence of tortuous appendages, but differed from it in the size of the spores. In the present isolate the spores are smaller, average size $4{\cdot}2 \times 2{\cdot}8\mu$ but in *T. spiralis* they have been described to be of a range of $5{\cdot}6 \times 2{\cdot}5$–$3{\cdot}0\mu$. On account of this and some minor differences such as colony colour and colour of the spores the present isolate deserves a new varietal name. It is being named *T. spiralis* var. *minuta* var. nov. A detailed description of the isolate is given below :

Trichurus spiralis Hasselbring var. *minuta* var. nov.

Coloniae viridulus ater ; sporiis viridulus griseus, $2{\cdot}8$–$5{\cdot}0 \times 2{\cdot}8$–$3{\cdot}2\mu$ (ut plurimum $4{\cdot}2 \times 2{\cdot}8\mu$)

Colonies on PDA[1] and SMA[2] at first greenish with radial folds, later becoming greenish black with small droplets often appearing on the surface ; reverse brownish to black, mycelium brownish, septate, 2–$3{\cdot}5\mu$ in diameter. In young colonies mycelium forms short or long conidiophores which show a great variability ; short ones produce catenulate conidia at their apex, elongated ones produce sterigmata like outgrowths either at different levels or at the same level which in turn bear catenulate conidia at their tip as in some Penicillia. In some, the sterigmata like outgrowths produce, either at their tips or as a side branch, a septate seta like outgrowth. At maturity the mycelium adheres into elongated rope like strands, which form dark clavate fruit bodies 1190–2660μ in length, with stalks 710–1610×16–45μ ; the fertile portion of the fruit body 420–1050×40–150μ giving rise to simple or branched sterigmata like outgrowths arising from the compact thick walled hyphae. In mature colonies the fruit bodies send out a number of secondary fruit bodies from their fertile region which may again produce still younger fruit bodies from their fertile region. From the fertile portion

1. PDA :—200 g. peeled potatoes, 20 g. glucose, 20 g. agar, 1 litre distilled water.
2. SMA :—Dextrose 40 g. Asparagine 2 g. $K.H_2PO_4$ 0·5 g., Mg $SO_4 \cdot 7H_2O$ 0·25 g. Thiamine Chloride 0·5 mg., distilled water 1 litre.


1
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of the fruit bodies arise a number of long, tortuous, septate, unbranched appendages, 45–105μ in length, 1·8–3·5μ wide hyaline at the base tapering at the apex into an acute or a blunt end. Spores oval to oblong 2·8–5·0 × 2·8–3·2μ mostly 4·2 × 2·8μ, greenish grey in mass. Type : Represented by a single isolate deposited in the culture collection of the Botany Department, University of Allahabad, No. 1–50. Dried specimen has also been deposited in the Herbarium of the same Department. Culture will also be deposited at Central Bureau voor Schimmelcultures, Baarn, Holland.

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EXPLANATION OF FIGURES

Trichurus spiralis var. *minuta* var. nov.

1. A mature fruit body sending secondary fruit bodies from its fertile region.
2. Fertile region of the fruit body enlarged.
3. A few mature spores.
4. Three germinating spores.
5. A young conidiophore.

6.–11. Conidiophores with catenulate conidia.

THE DIGESTIVE SYSTEM OF SOME BRITISH AMPHIPODS PT.—I. DESCRIPTION OF MOUTH PARTS

By

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INTRODUCTION

Hitherto, comparatively little attempt has been made to find out if any correlation exists between habitats, feeding habits, feeding appendages and alimentary canals of amphipods. In fact, no detailed description of the alimentary canal of any amphipod is available. With this idea in view 18 species of amphipods, with diverse habitats and feeding habits, were studied to find out a correlation, if any, could be established between these different aspects. Some forms selected are macrophagous such as *Orchestia* and *Gammarus*, others, like *Haustorius* and *Bathyporeia* are microphagous and *Chelura* is xylophagous while *Hyperia* lives within the body of the medusae and *Cyamus* is an ectoparasite on whales.

In this first part only the feeding appendages of the different amphipods are being dealt with. The alimentary canals, the feeding habits and their correlationship will be described in the subsequent parts.

The order Amphipoda is divided into three sub-orders, namely, (1) Gammaridea (2) Hyperidea and (3) Caprellidea. The different amphipods for the present work have been selected from all the three sub-orders. The feeding mechanisms of some of the animals were studied in detail, the gut contens of all the animals were also thoroughly examined to find out the diet of these animals. The feeding appendages of the animals were critically examined, especially with respect to the thickness of the chitin of the mandibles and other biting appendages. It was found out that the mandibles and maxillae of macrophagous forms are more heavily chitinised and strongly built to hold and crush the large pieces of food, but lack in well developed setae ; the appendages of microphagous forms are thin walled and setose to filter the fine food particles.

The alimentary canal, especially the fore gut, also shows certain interesting differences in these animals. Both cardiac and pyloric parts of the stomach are very strongly built in macrophagous forms for efficient mastication of food and also for filtering the smaller particles. In *Hyperia*, however, it is very simple with very few ridges and teeth. In *Cyamus*, the ridges are without any teeth or spines and are adapted for feeding on a liquid diet.

HISTORICAL

The order Amphipoda of the class Crustacea was early dealt by Spence Bate and Westwood (1855–65). Sars (1895) gave the distribution of different species in detail and also briefly described the mouth parts of some of the amphipods. Chevreux and Fage (1925) described the amphipods from the French coast. The habits and feeding of some of the animals, have been studied and described by more recent authors. Watkin (1938 and 1939) described the burrowing habits of

the genus *Bathyporeia*. The feeding mechanism of *Haustorius* have been described by Dennell (1933) and Crawford (1937) while Watkin (1940) described those of *Urothoe*. Calman (1921) and Barnard (1951) described briefly the habits of *Chelura*. *Caprella* was studied by Harrison (1940). Hart (1930) gave a detailed account of the burrowing and swimming behaviour of *Corophium*. Hollowday (1948) indicated that *Hyperia* usually inhabits the interior of certain jelly fishes. The external characters of *Cyamus* have been studied by Iwasa (1934).

MATERIALS

Many of the animals studied, such as *Orchestia, Talitrus, Marinogammarus, Corophium and Caprella* were collected at Whitstable seacoast where they occur in abundance (Newell, 1954). *Haustorius, Urothoe and Bathyporeia* were dug up from the Plymouth sands ; *Jassa, Gammarus chevreuxi* and *Melita* are commonly found in Plymouth waters (Plymouth Marine Fauna, 1957). *Isae*, which is found in the oral area of *Maia*, were also collected from Plymouth. *Chelura, Dexamine, Orchominella* and *Hyperia* were supplied by the Marine Biological Laboratory, Plymouth, in a preserved condition. *Gammarus pulex*, found in fresh water ponds, were collected from different localities. A few specimens of *Cyamus* were procured from the British Museum, Natural History, London.

METHODS AND TECHNIQUES

The feeding appendages of the animals were dissected out under the stereoscopic microscope. For the immediate study, temporary glycerine preparations were examined. For detailed study the appendages were treated with a very dilute solution of potassium hydroxide for an hour, to remove all the muscles, and after being dehydrated, were mounted in canada balsam. Another method of making permanent preparations of mouth parts, found easier and more useful, was to mount the different appendages directly in a mixture of polyvenyl lactophenol and indigo carmine. These preparations, after a few hours, gave a very clear picture of the details of the appendages which had taken a light pink colour of indigo carmine. Finally, the camera lucida diagrams were drawn from these preparations.

To study the arrangements of the mouth parts, the narcotised animals were examined, with their appendages in tact, under the stereoscopic microscope. The horizontal sections of the head also gave an idea about the arrangement of the mouth-parts. To examine the mouth parts in action, living specimens, whenever possible, were constantly observed either under the stereoscopic microscope, or under compound microscope, during the act of feeding.

MORPHOLOGY OF MOUTH PARTS

The feeding appendages of amphipods conform in many respects to a basic common plan but the finer details of structure vary a good deal in relation to differences of food and feeding habits. The first and second pairs of antennae, though not belonging to the series of the mouth parts, have also been included as accessory feeding appendages since they are helpful in the feeding mechanism of the animals.

The superior antenna of an amphipod, in general, consists of a three jointed peduncle or protopodite and a long flexible, many jointed flagellum or endopodite. A short accessory flagellum or exopodite is usually present at the junction of the peduncle and flagellum. The inferior antenna also consists of jointed protopodite bearing a many jointed flagellum or endopodite each articulation of which may carry a calceolus.

Each jaw or mandible consists of a strong protopodite, which includes a masticatory part or cutting edge and molar expansion. The former has at least one long curved incisor tooth. The molar expansion at its outer edge, is usually armed with a double row of saw-like teeth. Each mandible may have a three jointed palp or endopodite.

The first maxilla is usually tri-partite. The protopodite is divided into an inner basal lobe and an outer masticatory lobe, bearing a jointed endopodite or palp on the outer margin. The second maxilla consists of only two flat lobes of which the inner one (protopodite) is a little smaller than the outer endopodite.

The two maxillipeds of either side are fused by their protopodites to form a sort of lip of the buccal mass. The protopodite of each maxilliped consists of a small basal lobe and a larger masticatory lobe. The endopodite or palp is usually very large and many jointed.

The anterior lip and epistome are fused together to form a compound oval structure. The anterior lip is a flattened bilobed structure bearing lateral horns.

FEEDING APPENDAGES IN SUB-ORDER GAMMARIDEA

Family Talitridae :—The family includes the sand hoppers commonly found along the line of decaying weed at high water mark of the sea-shore. This is the only group of amphipods in which some of the members have foresaken the sea for land. *Orchestia gammarella* Pallas, is very commonly found at high water, under weeds and stones ; it is, sometimes, found several miles away from the water. The animal is about 18 mm. long and is reddish brown in colour. (Plate I)

The superior antenna of the animal is rudimentary and without an accessory flagellum. The inferior antenna is comparatively very large. Both pairs of antennae bear small but strong spines.

Thickly chitinous mandibles are very strong and are without palps. The masticatory part bears six very strong and pointed incisors arranged in two rows of three each. The molar expansion of each jaw forms an oval bulging, with its outer edge strongly serrated During feeding, the two expansions of either side come together for partial mastication of food. Few strong feathered spines are present between the incisors and molar expansions.

The first maxilla is also strong and is without a palp. The large masticatory lobe has, distally, nine very strong spines which bear nodule-like structures on their inner edges ; the small basal lobe has only two, distally placed, spines. Both inner and outer lobes of the second maxilla bear unfeathered spines, distally.

The basal lobe, masticatory lobe and palp of the large maxilliped are all clothed with a large number of small spines.

Both anterior and posterior lips are furnished with a large number of small spines, on the edges facing the mouth.

Talitrus saltator Montagu, is about 20–25 mm. long and is brownish grey in colour. They are abundantly found along high water mark, associated with rotting sea weed or other debris which preclude the evaporation of moisture. During summer, *Talitrus* burrows into sand to a depth of 2 or 3 inches until moist conditions are found.

The mandibles, like those of *Orchestia*, are strongly built, especially the molar expansions which bulge out as oval structures and have deeply serrated edges. There are no palps.

The first maxilla is very large, with a narrow basal lobe which has only two feathered spines and does not have a palp. Its masticatory lobe is very large with strong curved tooth-like projections, distally. The second maxilla is flattened and has thick spines on both the lobes.

The maxilliped has a large basal lobe and a poorely developed masticatory lobe. The palp bears small blunt spines.

Family Haustoridae is represented in the coastal waters of Great Britain by three genera *i.e. Bathyporeia*, *Haustorius* and *Urothoe*, all of which are characterised by their habits of burrowing in sand. They burrow more easily in loose deposits, for which purpose the three posterior pairs of periopods are peculiarly modified, the extreme development in this respect is found in the genus *Haustorius.*

Bathyporeia pilosa Lindstrom :—The genus *Bathyporeia* was first established by Lindstrom in 1855. Bates (1856 and 1857) described it as a new genus *Thersites*, which he later withdrew in favour of the name *Bathyporeia.* Watkin (1938) has discussed the burrowing habits of the genus in some details. Animals of the genus *Bathyporeia* are abundantly found in the inter-tidal sands around the sea coasts, extending into comparatively deep water.

The feeding appendages of the animal (Plate II) exhibit marked differences than those of other amphipods. The superior antenna is much smaller in the female than in the male. A bi-articulate accessory flagellum is present. In the male, the flagellum shows some secondary sexual characters, as its articulations, except the last two, bear oval calceoli. The inferior antenna is also large in the males ; and bears calceoli on its flagellum.

The mandible, though large, is not thickly chitinous. Two overlapping curved incisors of the masticatory part, protrude like an elongated rod. The molar expansion, with its serrated margin, forms but a small bulge. In between the incisors and molar expansion are to be seen four feathered spines. The tri-articulate palp bears a large number of long spines.

The first maxilla has an uni-articulate palp with plumose spines, distally. The masticatory lobe is large and bears, distally, six strong plumose spines. The small basal lobe also carries a few feathered spines. Both the lobes of the second maxilla bear a large number of feathered spines.

The maxilliped bears a basal lobe, a masticatory lobe and a large palp. The basal lobe carries a few long plumose spines, and four thick knob-like structures. The masticatory lobe, internally, bears strong spines. The ante-penultimate joint of the palp is obtusely produced inwards, at its end ; it is clothed with numerous transverse rows of delicate long spines. The penultimate joint is much constricted at its base and abruptly elongates distally.

Haustorius arenarius Slabber has been recorded as an inhabitant of the intertidal and shallow water sands of the coasts of Britain ; the characterstic shape of the body is regarded as an adaptation to its burrowing habit. At periods of high water, it may leâve sand, to swim freely.

Bate (1857) and Sars (1895) described only the female of *Haustorius.* Watkin (1941), however, recorded the presense of the male which does not show any apparent external differences from the female. Dennell (1933) has described the habit and feeding mechanism of the animal.

Adult *Haustorius* is about 8 mm. long with short and robust body. The superior antenna has a very large peduncle, which carries a number of very large

feathered spines. (Plate III) The flagellum bears small simple spines. The peduncle of the inferior antenna is also clothed with large feathered spines. Its middle joint, posteriorly, forms a broad lamellar expansion, fringed all along its posterior border, with very long and hairy setae.

The large flattened mandible is not thickly chitinous. The masticatory part has a few weak, forked incisors. The rudimentary molar expansion is covered with a few very fine setae. Between the masticatory part and molar expansion, are present a few strong spines, below which the margin is serrated. The palp is very large and bears numerous large spines.

The basal lobe of the first maxilla, scarcely projects from the body and bears a few feathered spines. The large masticatory lobe has a few strong spines which bear small teeth at the lower margin ; its palp also carries many strong spines.

The second maxilla of *Haustorius* is a large flattened foliaceous structure. Its outer lobe, a thin semilunar lamella, bears a large number of long feathered spines. The inner, stouter lobe also bears long spines.

The maxilliped is a large thin and flattened structure ; its basal lobe has a small additional accessory lobe which bears two strong spines. The masticatory lobe has only a few strong spines. The palp is very large, its penultimate segment, overlapping the masticatory lobe, is especially well developed. The whole of the palp is clothed with plumose spines.

The anterior lip is without spines. The large posterior lip is bilobed and carries a few large and a few small bristles.

Urothoe marina Bate is also commonly found in the inter-tidal and shallow water sands, often in the same habitat as *Bathyporeia* and *Haustorius*. Crawford (1937) and Watkin (1940) have described the burrowing habit of the genus in some details. The animal is about 5 mm. long ; the cephalon is rather large and broad.

The inferior antenna (Plate IV) is large in the male than in the female and its flagellum carries small calceoli on different segments.

The mandible, though not strongly built, is very large considering the size of the animal. The masticatory part bears a pair of straight incisor teeth ; unlike other amphipods, the outer edge of the molar expansion is more or less smooth. There are no spines between the incisors and molar expansion. The palp is extremely large with a few long spines.

The first maxilla has a small basal lobe with only a pair of spines. The large masticatory lobe has, at its tip, about a dozen feathered spines. The large palp has only three plumose spines, at its top. Both the lobes of the second maxilla bear plumose spines at their distal ends.

Both basal and masticatory lobes of the maxilliped are equally well developed and carry a few knob-like spines. The large palp has its ante-penultimate segment much flattened. The penultimate joint is strongly constricted at the base and is gradually dilated distally to form a club-shaped structure.

The anterior and posterior lips are built on the usual plan.

Family :—Dexaminidae has been represented by *Dexamine spinosa* Montagu ; the animal is about 15 mm. long and is found in moderate depths, ranging from 6 to 30 fathoms, among algae.

The superior antenna (Plate V) is very long and slender. There is no accessory flagellum and the spines are very short. The inferior antenna is also long and slender with very small and slender spines. Each articulation of the flagellum bears a small calceolus.

The mandible is without a palp. The strong and thickly chitinous masticatory part has an upper set of four incisors and a lower set of three incisors. The molar expansion projects well from the body of the mandible. Its outer edge has a large number of small spines. Three simple spines are present between the incisors and molar expansion. The strong masticatory lobe of the first maxilla bears halt a dozen spines at the top. Each spine has a tooth-like process at one side. The uniarticulate palp has a few conical teeth. The second maxilla has long unfeathered spines.

The maxilliped is long and narrow. The basal lobe is small. The masticatory lobe is exceptionally large and flat with strong hook-like spines The small palp, only slightly projects beyond the masticatory lobe.

Family—Isaeidae:—

Isaea montagui Dana of the family Isaeidae was described by Dana who had established it in sub-family Isaeanae. Bate (1855) studied the animal briefly.

The animal is very commonly found between the mouth parts of *Maia.* I found them in practically all the crabs examined.

Both superior and inferior antenna are fairly large with small spines. The strongly built mandible (Plate VI) has a few thickly chitinous incisors. The molar expansion has its edge serrated. Between the incisors and molar expansions, there are seven strong spines, each bearing small teeth on their upper surface. The tri-articulate palp is proportionately large.

The tri-articulate palp of the first maxilla is arched over the well developed masticatory lobe. Both the lobes of the second maxilla are clothed with plumose spines.

The large masticatory lobe of the maxilliped bears a few teeth-like spines. The rest of the structure bears a large number of spines. The bilobed posterior lip has another internal lobe, also provided with fine spines.

Family—Jassidae :—

Jassa falcata Montagu of the family Jassidae was known as *Podocerus falcata* until 1899 when Stebbing grouped it in the genus *Jassa* of Leech. Sars (1895), Walker (1911), Sexton (1911) and Barnard (1932) gave a comprehensive account of the animal.

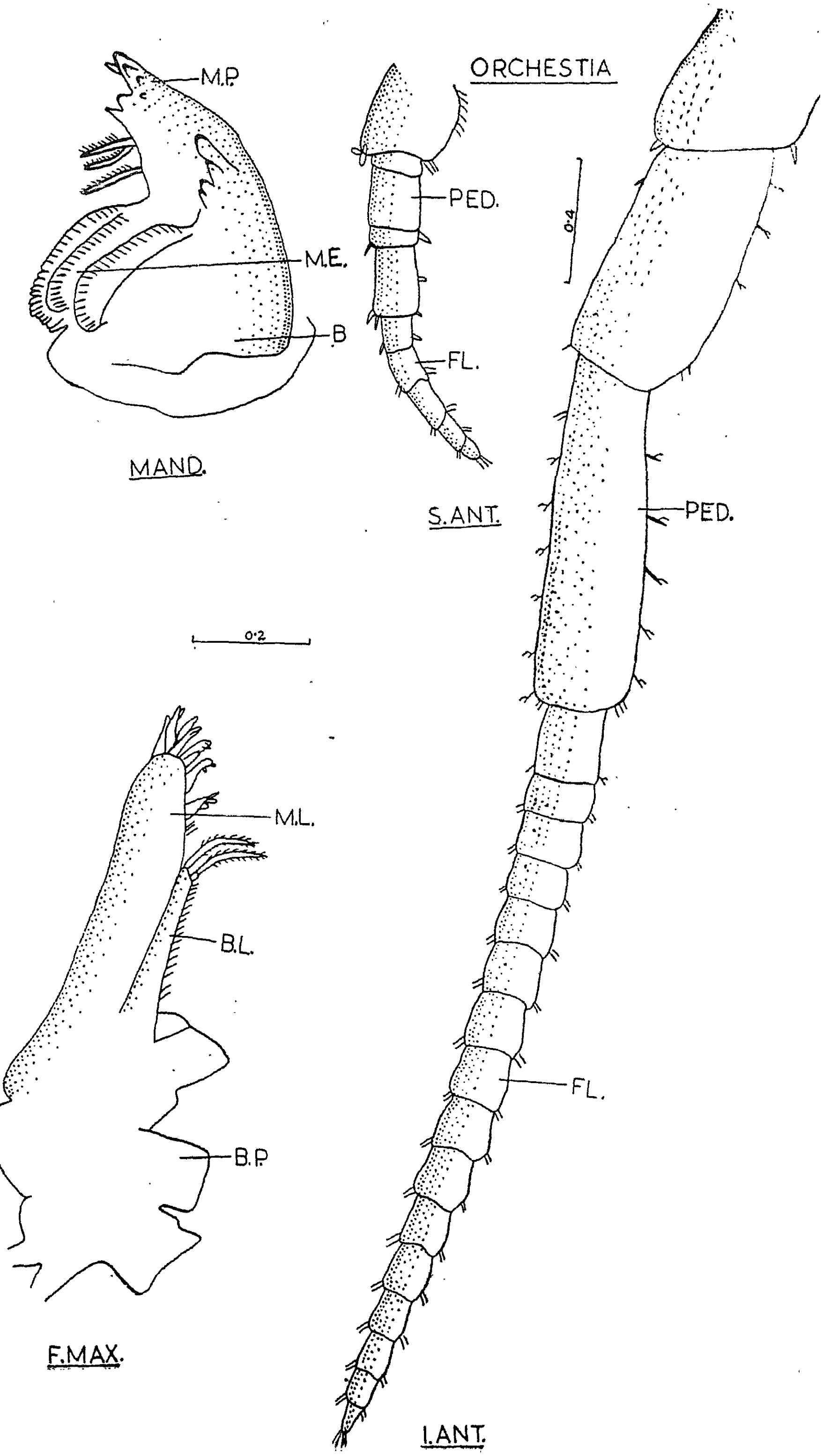
Both superior and inferior antenna are very large with very long feathered spines. (Plate VII).

The mandible, though weak is an exceedingly large structure. There are a few small incisors ; the molar expansion has a few fine bristles. The very large feathered palp also bears long plumose spines.

The first and second maxillae are also heavily clothed with long feathered spines. The maxilliped is very large. Both, basal and masticatory lobes of the maxilliped have a few knob-like spines and a few long ones. The large palp also has long spines.

The anterior and posterior lips are built on the usual plan.

PLATE I


ORCHESTIA
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S. ANT.
0·4
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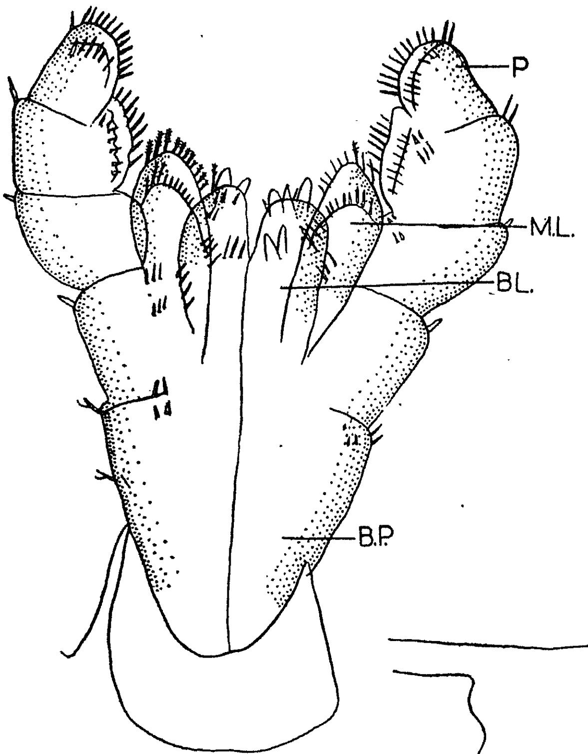
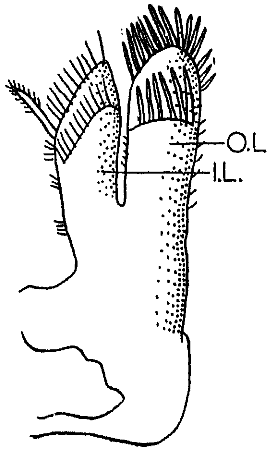
B.L.
B.P.
F. MAX.
FL.
I. ANT.

PLATE I *a*

ORCHESTIA





S.MAX.

MAX.PD

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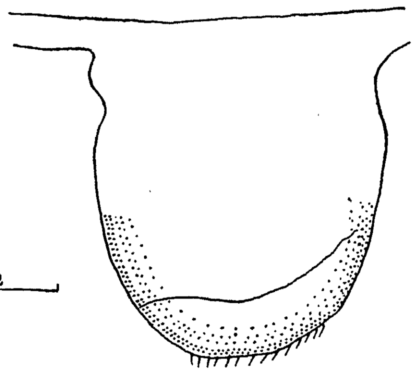


A.LIP

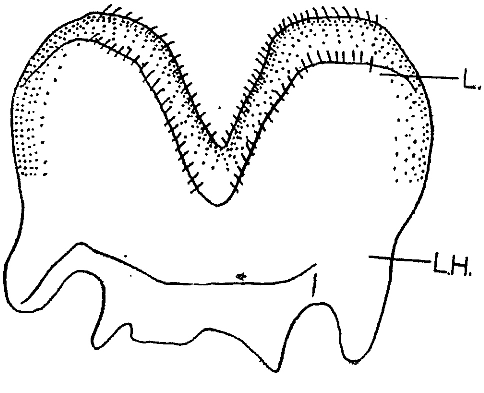
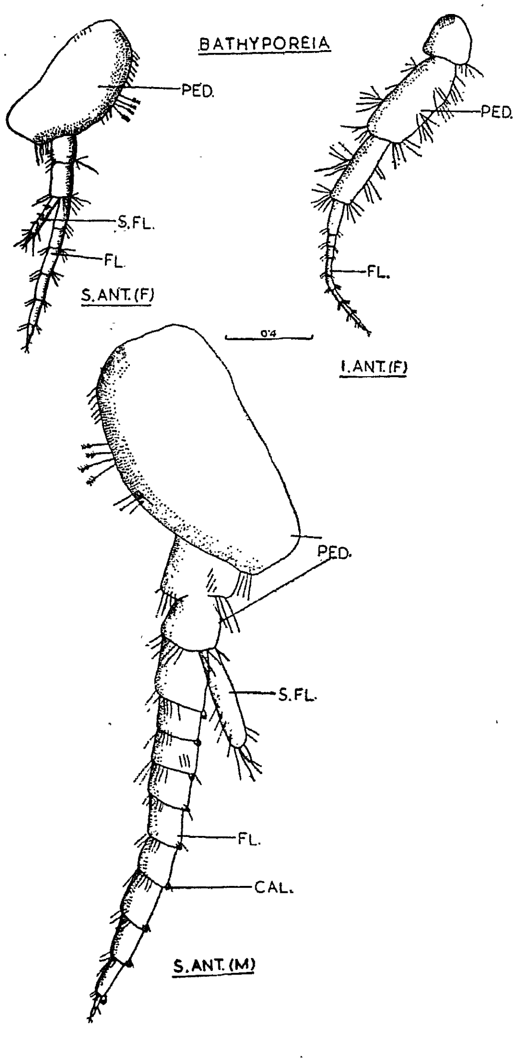


PLATE II


BATHYPOREIA
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FL.
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S.FL.
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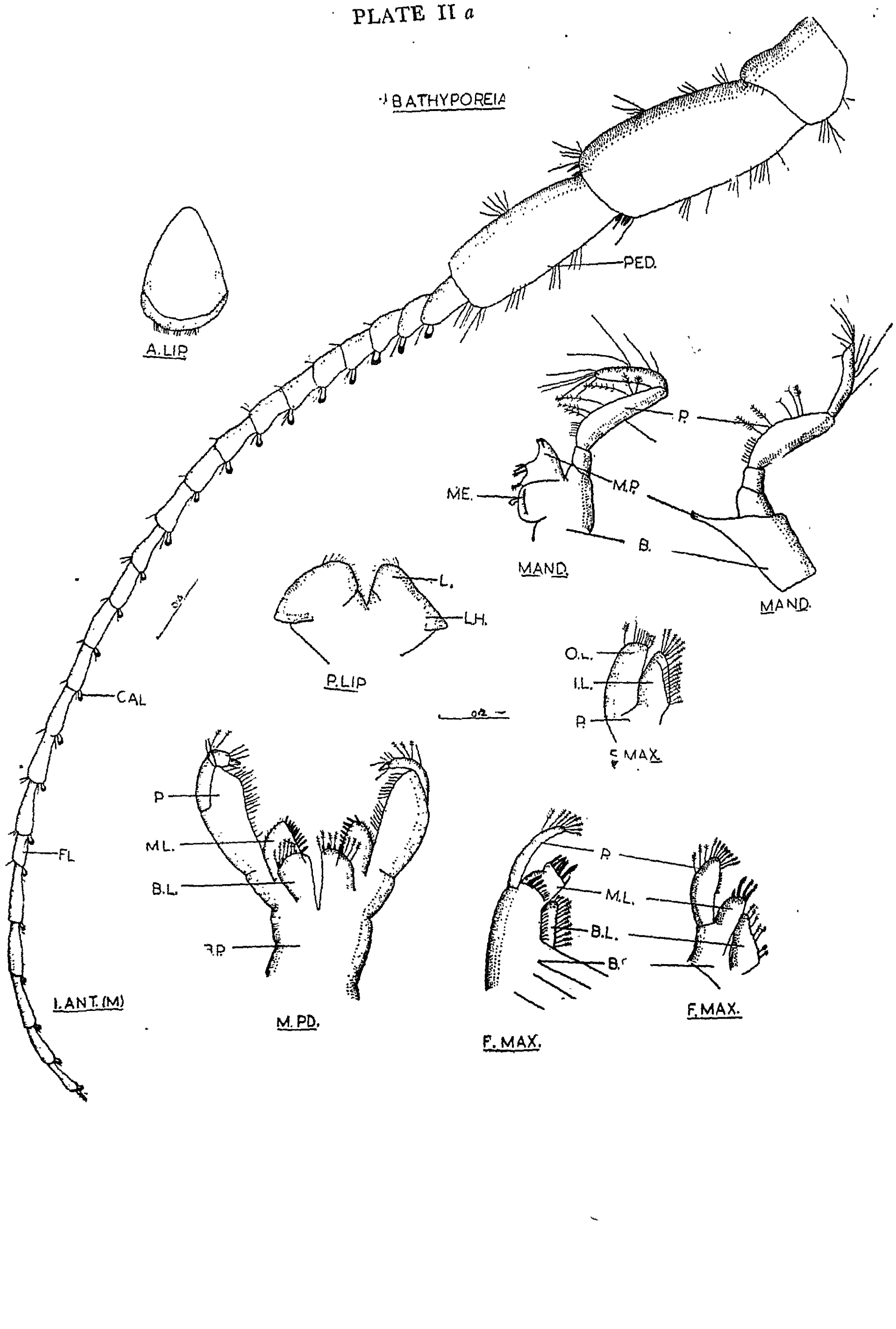
CAL.
S.ANT.(M)

PLATE II *a*


BATHYPOREIA
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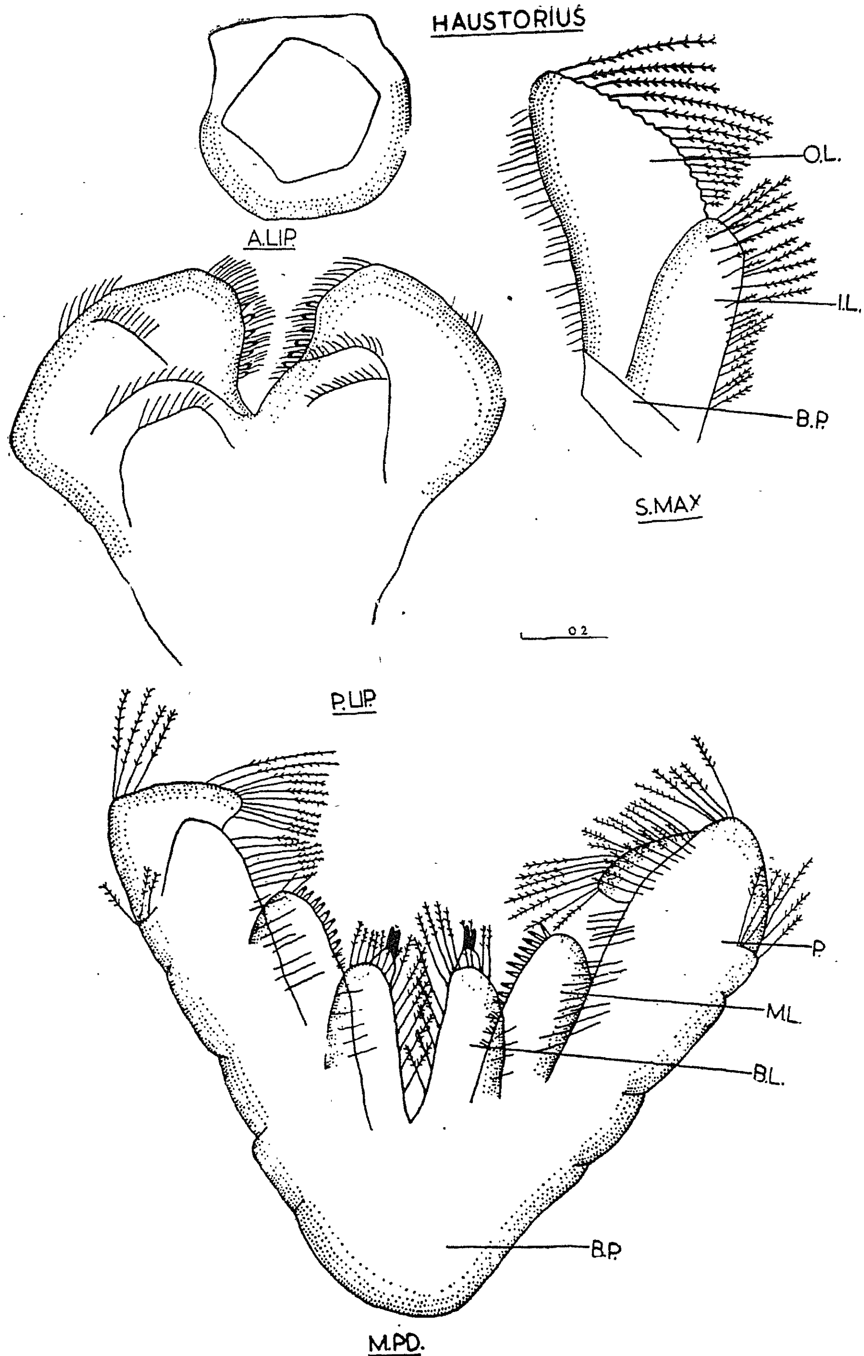
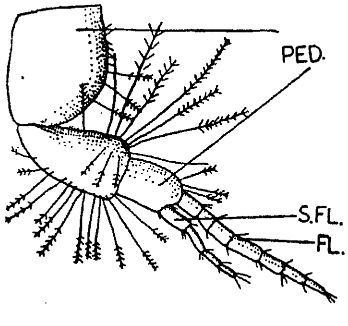
F.MAX.

PLATE III

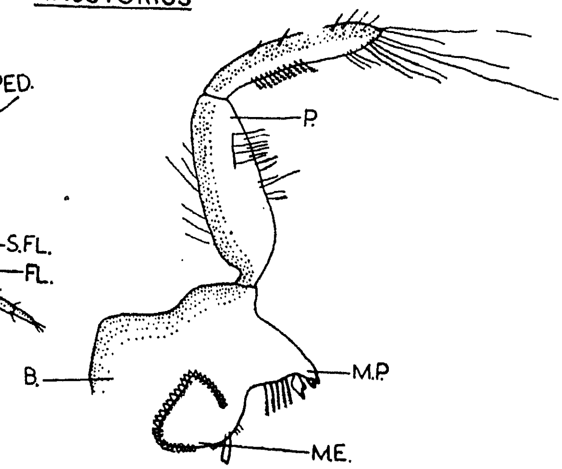


LATE III *a*

HAUSTORIUS



S. ANT.



MAND

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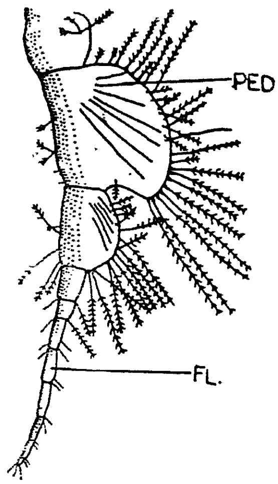
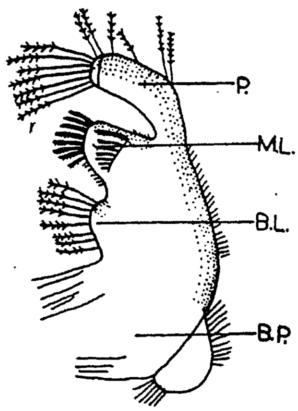
0·2

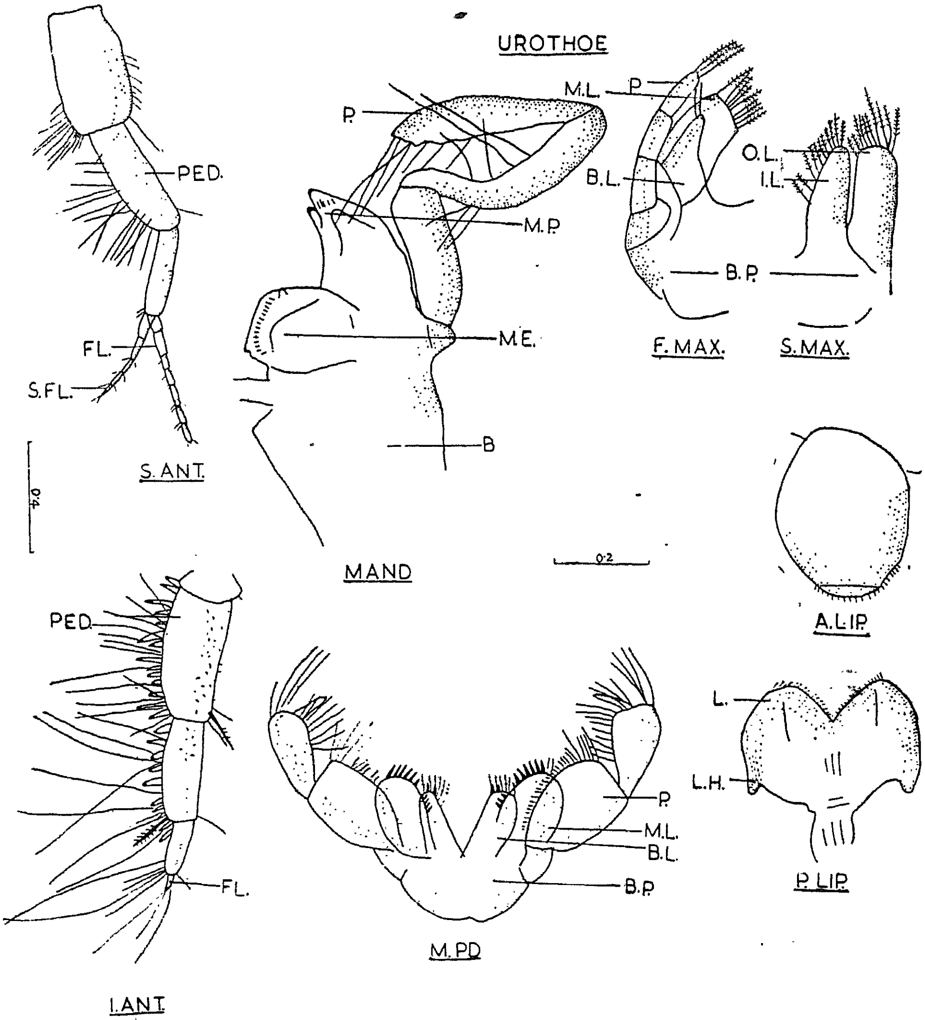


I. ANT.



F. MAX.

PLATE IV



UROTHOE
PED.
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S.FL.
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B.L.
B.P.
F. MAX.
O.L.
I.L.
S. MAX.
A.LIP.
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M.PD.
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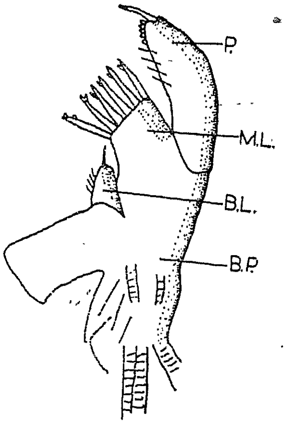
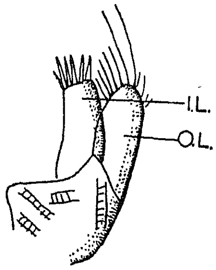
P.LIP.

PLATE V

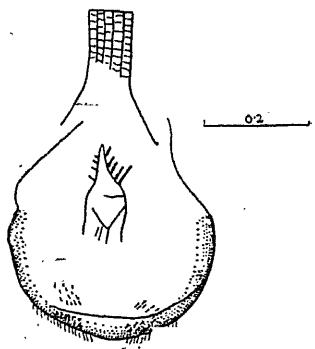
DEXAMINE



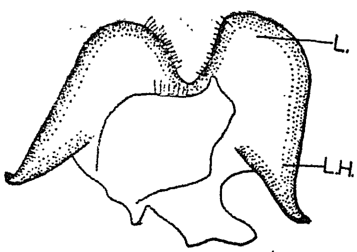
F. MAX.



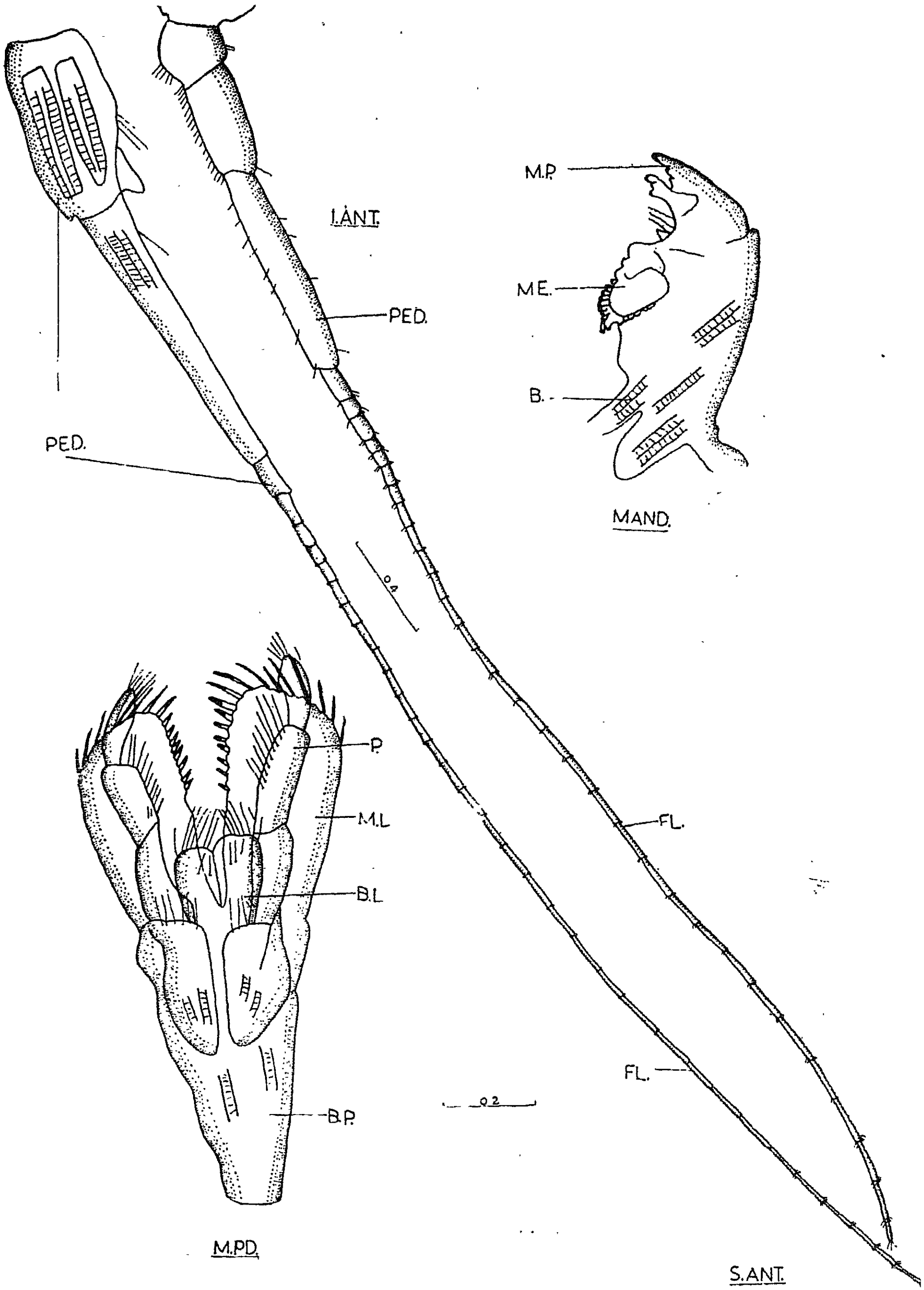
S.MAX.



A.LIP.

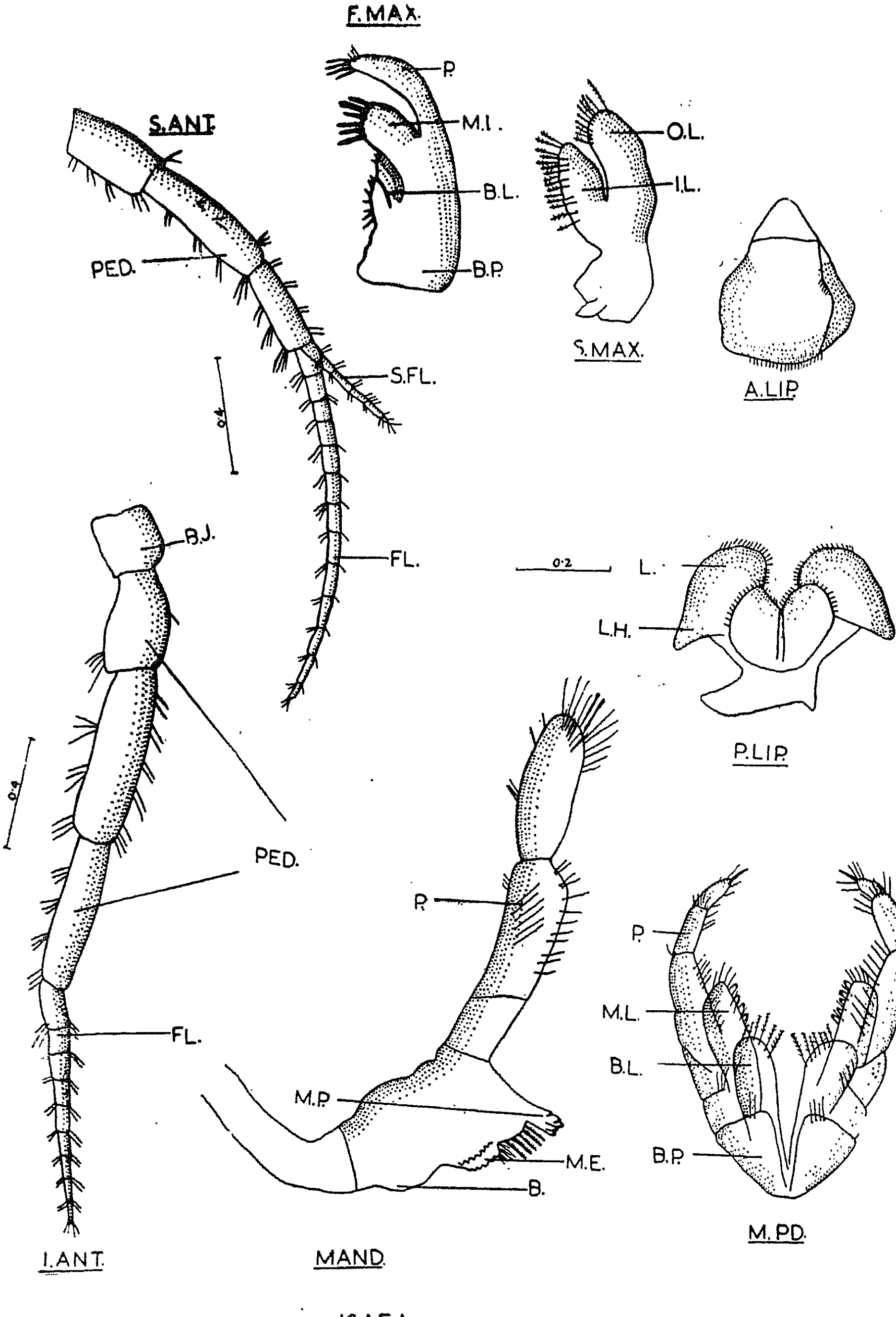


P.LIP.



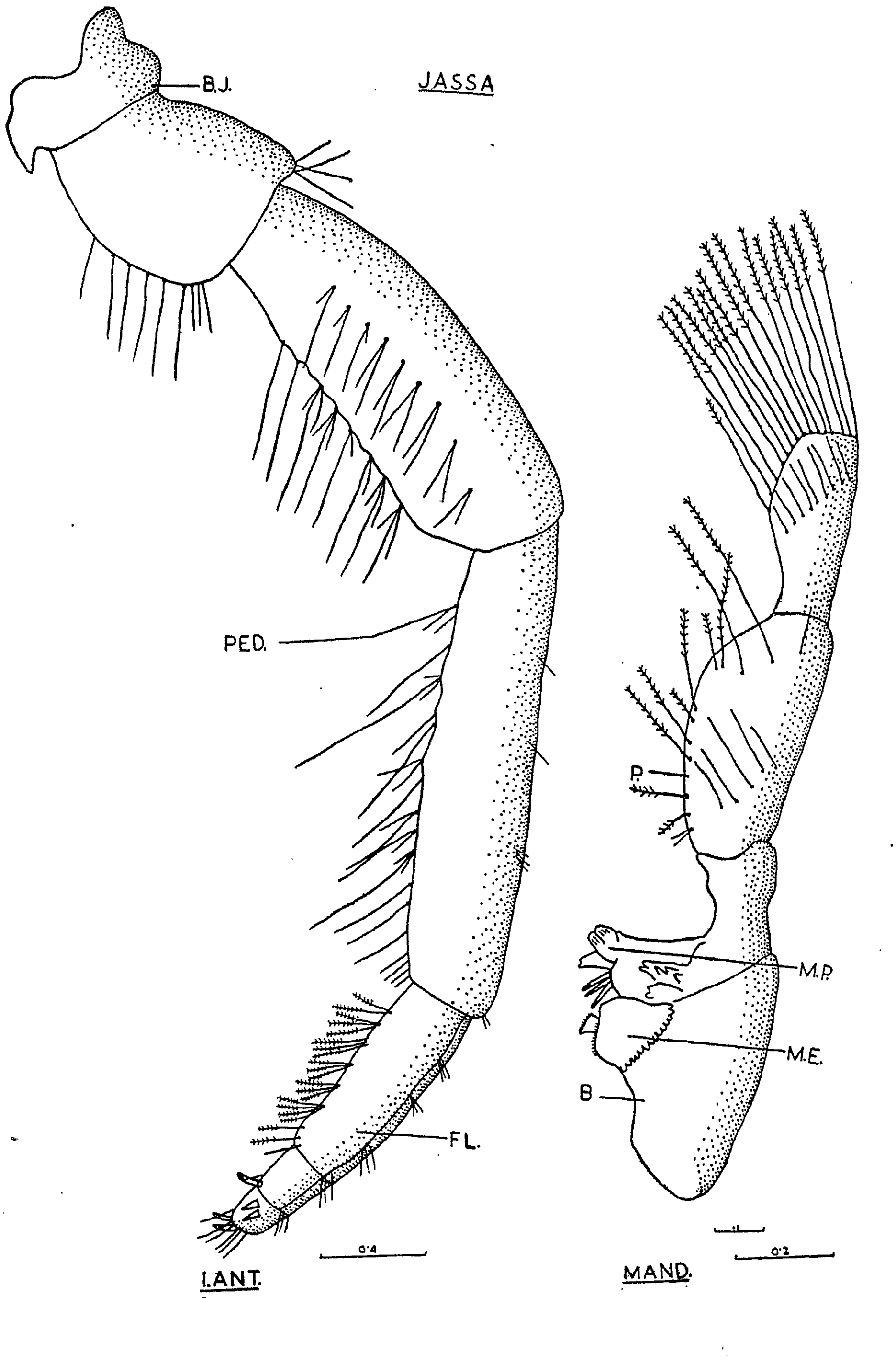
DEXAMINE

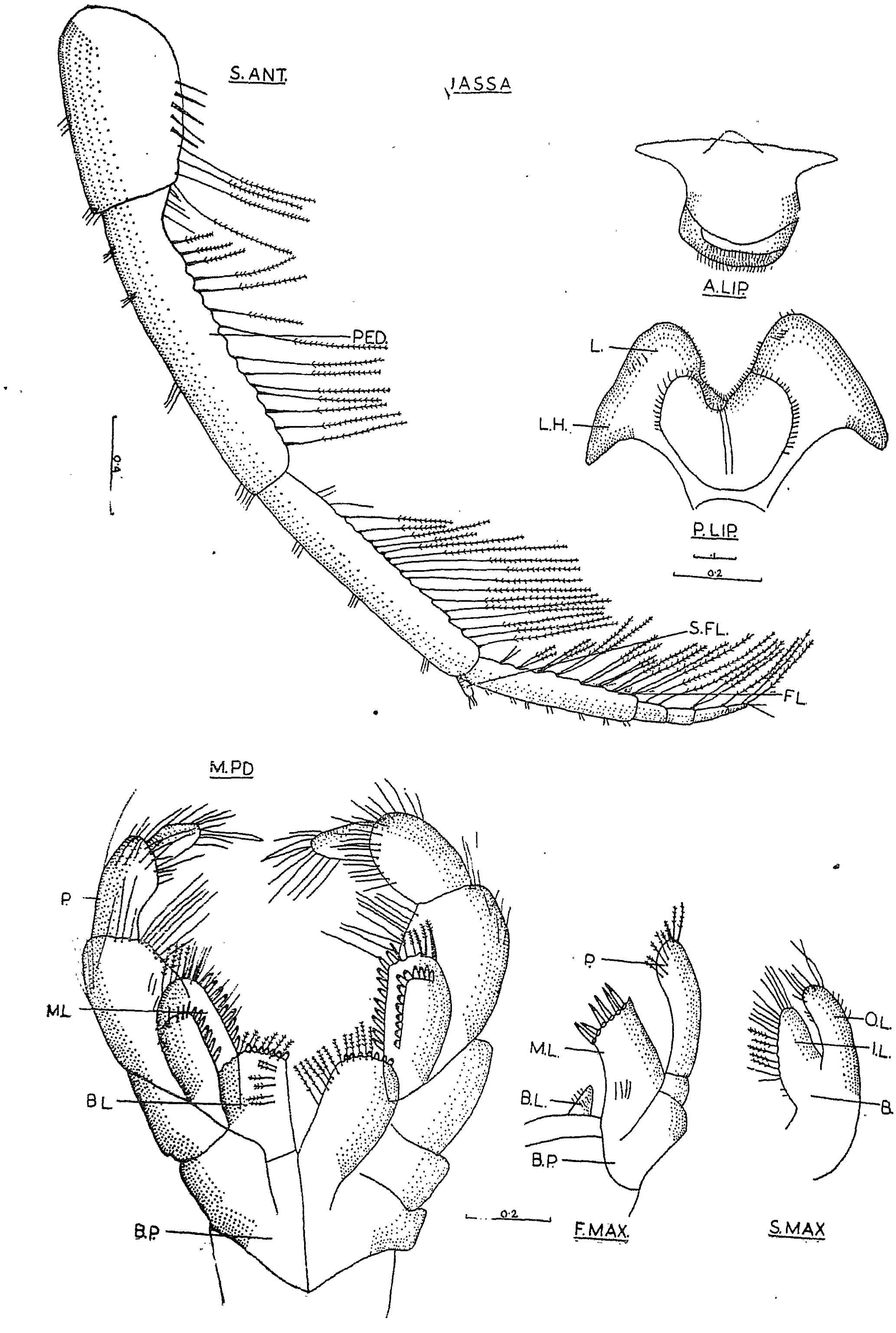
PLATE VI



ISAEA

PLATE VII




S. ANT.
JASSA
A. LIP.
PED.
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S.FL.
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ML
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B.L.
B.P.
O.L.
I.L.
B.P.
0·2
F.MAX.
S.MAX

SUMMARY

1. A few amphipods with diverse habits and habitats have been selected.

2. The feeding appendages, including mouth parts proper and the two pairs of antennae have been very thoroughly examined.

3. It has been found that the mandibles and maxillae, which are mainly concerned with the mastication of food have very strongly developed teeth-like structures in the macrophagous forms.

4. The feeding appendages of microphagous forms are setose to filter the small particles of food.

ACKNOWLEDGMENT

My sincere thanks are due to Prof. J. E. Smith., F.R.S. of London University under whose supervision this work was conducted.

ABBREVIATIONS USED.

A.Lip.—Anterior Lip ; B.—Body ; B.J.—Basal Joint ; B.L.—Basal lobe ; B.P.—Basal part ; Cal.—Calceolus ; Fl.—Flagellum ; F.Max.—First Maxilla ; I.Ant.—Inferior antenna ; I.L.—Inner lobe; L.—Lobe ; L.H.—Lateral Horn ; Mand.—Mandible ; M.E.—Molar expansion ; M.L.—Masticatory lobe ; M.Pd.—Maxilliped ; M.P.—Maxillary part ; O.L.—Outer lobe ; P.—Palp ; Ped.—Peduncle ; P.Lip.—Posterior lip ; S.Ant.—Superior antenna S.Fl.—Accessory flagellum ; S.Max.—Second Maxilla;

N.B.—Male (M) and female (F) figures are given separately, only in those cases, where the feeding appendages are different in the two sexes.

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A PRELIMINARY STUDY OF THE LIFE HISTORY AND CONTROL OF *INDARBELA QUADRINOTATA* WLK. (METARBELIDAE : LEPIDOPTERA)

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Indarbela quadrinotata Wlk. and *Indarbela tetraonis* Moore, are commonly found in Uttar Pradesh. Very little work has been done on these borers in India. Hayes (1945), Sontakay (1947), Lal (1952) and Srivastava (1956) have given a short account of *Indarbela quadrinotata* Wlk. and its control in Uttar Pradesh and Madhya Pradesh. In Utter Pradesh practically no work has been done on this pest so far. The caterpillar of *Indarbela quadrinotata* Wlk., commonly known as Bark-eating caterpillar, is one of the most serious pests of *guava* in Uttar Pradesh. Hardly there is any orchard that has escaped the ravages of this pest. Out of eight guava orchards surveyed in Uttar Pradesh, all of them were found to be severely infested with this pest. The table given below shows the incidence and intensity of bark borer in the trees examined at random in the various orchards :—

TABLE

Incidence and intensity of *Indarbela quadrinotata* Wlk.

Sl. No.	Names of the Districts where the orchards are situated	No. of trees present in the orchard	No. of trees examined (at random)	No. of trees found affected	Incidence and intensity of the attack
1.	Fatehpur	400	40	40	Cent percent trees found affected with an average of 15 caterpillar per tree.
2.	Do.	400	40	40	Cent percent trees affected with an average of 5 caterpillars per tree.
3.	Do.	150	15	15	Cent pereent trees found affected with an average of ten caterpillar per tree.
4.	Do.	300	30	29	About 96% trees affected with an average of 8 caterpillars per tree.

Sl. No.	Names of the Districts where the orchards are situated	No. of trees present in the orchard	No. of trees examined (at random)	No. of trees found affected	Incidence and intensity of the attack
5.	Lucknow	200	20	20	Cent percent incidence with an average of 10 caterpillars per tree.
6.	Do.	180	20	19	95% trees affected with an average of four caterpillars per tree.
7.	Unnao	100	10	10	Cent percent incidence with an average of 18 caterpillars per tree.
8.	Kanpur	25	4	4	Cent percent, with an average of two caterpillars per tree.

It is evident from the above table that the pest is wide spread in Uttar Pradesh and has become a great menace to guava orchardists. It has been observed that older trees are more severely attacked than the younger trees. The smooth surface of the bark and absence of many cracks and crevices in young trees, might be one of the factors responsible for less attack of this pest on them, as the moths are in habit of laying eggs under the loose bark of stem and branches or near the cracks and crevices which provide shelter for larvae in early stages of their life. It has been further observed that trees situated in shady places show a higher incidence than those exposed to sun.

The attack of this pest on trees is characterised by the presence of long, winding, thick, blackish or brownish ribbon like masses, composed of small chips of wood and excreta both of which intermixed with the help of adhesive material secreted by the caterpillar. This ribbon like mass is locally known as 'Jala' or 'Tanda'.

Nature of Damage :

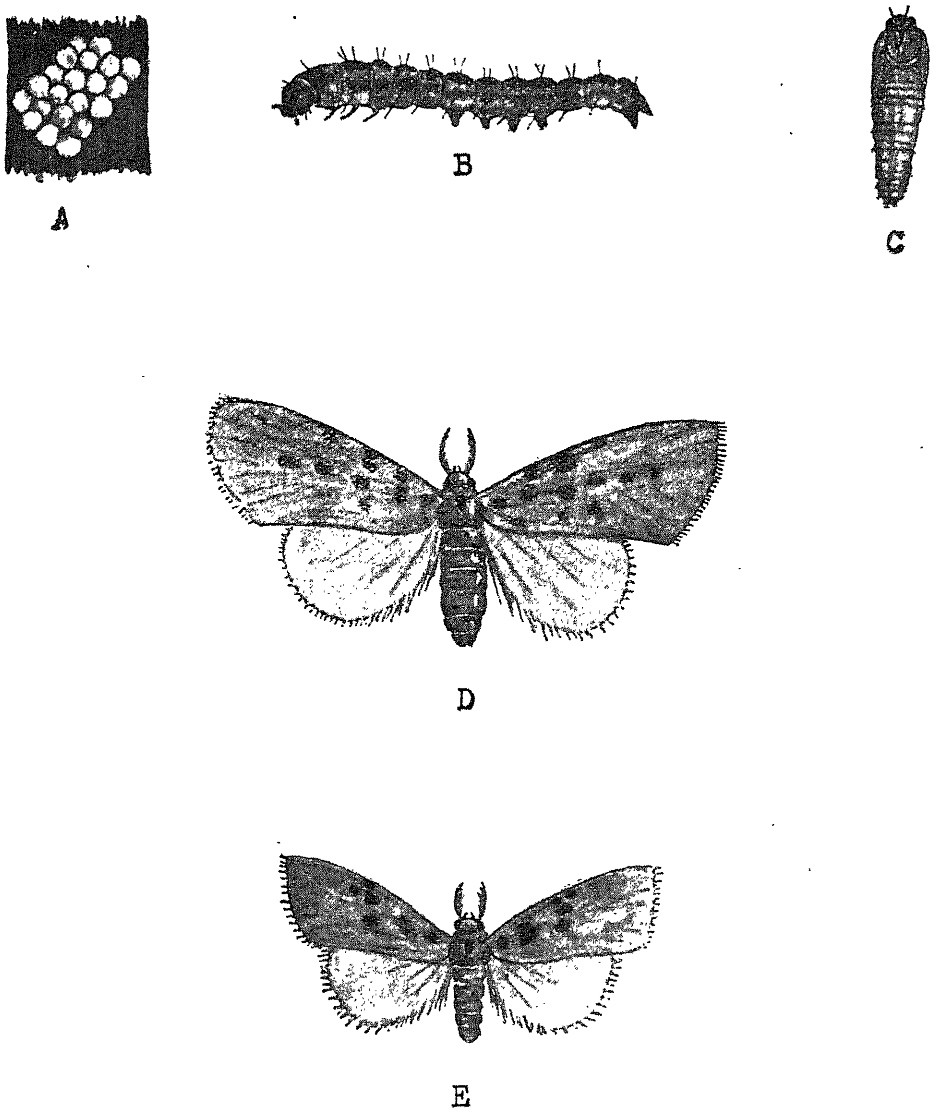
The caterpillar feeds on the bark of the tree resulting in the destruction of sap conducting tissues thereby affecting the vitality of the tree and consequently the yield and quality of the fruit becomes poor. Further damage is caused by its habit of making tunnels into the stem and branches for shelter and in case of severe infestation the tree becomes weak and may even die.

Indarbela quadrinotata Wlk. has been reported to attack a large varieties of fruits, forest and ornamental trees and shrubs. A serious outbreak of this pest has been reported in citrus orchards in Madhya Pradesh. Among the plants of economic importance it has been reported on mango, orange and pomegranate.

Description of Moth :

Male :—The head and thorax of the the male are light brownish red in colour. The fore wings are pale brown and are marked with numerous dark brown bands of strigae. The abdomen and hind wings are light brown in colour. It measures about 36 millimeters across the wings.

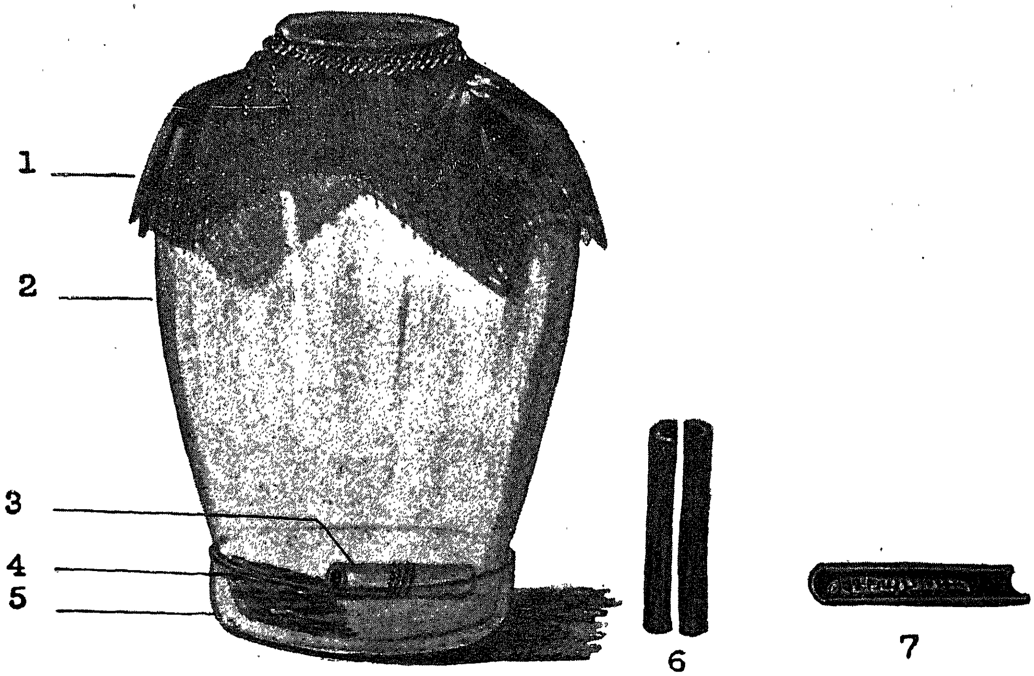
STAGES OF *INDARBELA QUADRINOTATA* WLK.



A. A cluster of eggs.
B. Full grown caterpillar.
C. Pupa.
D. Female moth.
E. Male moth.

PLATE

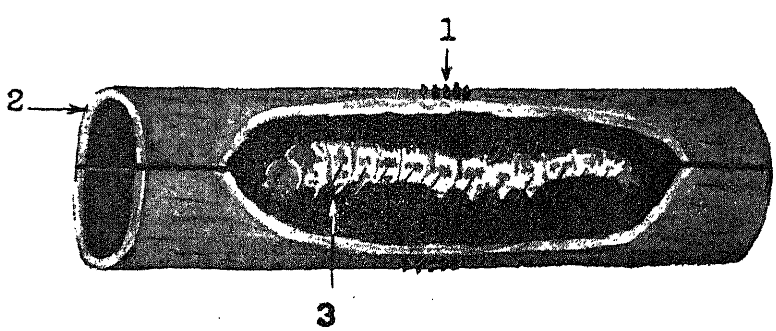
DIAGRAM SHOWING THE TECHIQUE OF REARING OF *INDARBELA QUADRINOTATA* WKL. IN LABORATORY



1. Netting cloth.
2. Glass chiminey.
3. Wooden tube.
4. Chips of the bark of guava tree.
5. Petri dish.
6. Two pieces of the tube shown separately.
7. One piece of the tube removed open to show the caterpillar inside it.

PLATE 3

A PORTION OF THE TUBE CUT OPEN TO SHOW THE CATERPILLAR INSIDE IT.



1. Thread, 2. Tube, 3. Caterpillar.

Female :—The head, thorax and abdomen of the female are pale in colour. The fore wings are also pale in colour with the markings as in male. Hind wings are pale having a tinge of brown colour, and are marked with numerous absolescent brown strigae. The female measures about 40 millimeters across the wings. The moths are very short lived and die after laying eggs.

Rearing technique in laboratory :

The pest has been successfully reared in the laboratory by the following technique. Wooden tubes closed at one end and measuring about 3 ." in length and quarter to one inch in diameter were made (Plate 2 and 3). It has been found convenient to have the tubes made of two pieces tied together by means of a thread. This provides an easy access to the caterpillar hiding inside the tube. The two pieces of the tube may be pulled apart, whenever needed, and the caterpillar may be taken out of the tube for study. These tubes were placed in petri dishes covered with glass chimney as shown in the diagram. A larva was released in each of these tubes. Small chips of fresh bark of guava trees were placed in the dishes near the opening of the tube for the food of larva. The chips of bark were changed with fresh bark on alternate days. The dishes and tubes were kept clean and dry. The larvae come out of their tubes in the night and after feeding on the chips of the bark return back into their tubes.

Life History :

Eggs :—The moths are sexually mature soon after emergence from the pupa and copulate within 25 hours of emergence. The eggs are laid in the month of June. The female moth lays eggs in clusters of 15–25 eggs under loose bark of the branches and stems or near the cracks and crevices.

Larva :—The period of incubation is about ten days and small larva on hatching starts making ribbon like masses and hides under it, feeding on bark. As it grows older, it starts boring into the wood of stem and branches and makes tunnels for shelter. The caterpillar is nocturnal in habit and remains concealed in the tunnel during the day. It comes out of its tunnel at dusk and feeds on the bark and the underlying tissues, keeping itself hidden under the cover of ribbon like mass. The caterpillar when gully grown measures about 50 millimeters in length and is of greyish brown colour with dark greyish brown patches on the dorsal and lateral sides of each segment. It continues feeding on the bark and the underlying tissues till about the third week of April.

Pupa :—Pupation starts in the last week of April and continues till the second week of May. Before the pupation the caterpillar stops feeding and webs up a case of fine chips of wood and excreta with the aid of adhesive material, inside the tunnel and pupates in it. The pupa is redish brown in colour and measures about 25 millimeters in length. The pupal stage lasts for about 28 days and emergence of moth from the pupa is completed by the third week of June. Only one generation of the insect in a year has been recorded in U. P.

Methods of control :

Mechanical :—The caterpillars may be killed mechanically by inserting iron spike into the tunnels of caterpillar. By this method as many as 75% caterpillars may be destroyed.

Chemical control :—The pest has been successfully controlled by injecting a mixture of ethylene glycol and kerosene oil (one part of ethylene glycol and three parts of kerosene oil) into the tunnels by means of syringe and then sealing the opening of the tunnel with mud. The caterpillars are killed inside the tunnel by

the poisonous vapours liberated by the mixture of ethylene glycol and kerosene oil. The method involves little technical knowledge or experience and may be applied by an ordinary man. Cent percent mortality of the pest is achieved if the treatment is applied twice.

Conclusion :

Although borers occupy a very important position in view of the damage they cause to crops and trees, very little work has been done on these pests. In fact they provide a very interesting field researches on various aspects of their life. The present studies were undertaken to give a short account of bionomics and control of *Indarbela quadrinotata* Wlk. which has assumed the form of a most serious pest of guava in U. P. Detailed studies on the bionomics, morphology of larva and adult and various other aspects, are yet to be undertaken.

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SOME PREVALENT PLANT DISEASES IN SIKKIM--1

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INTRODUCTION

Sikkim, often called 'Bay Yul Demo Jang' or the hidden valley of rice is a small hilly state north of Darjeeling district with an area of 2,812 square miles. It is bounded by Tibet on north and east; Nepal and west of Darjeeling district on south and Bhutan towards the south east. About half the area is under glaciers, snows and lakes. The highest peak is in the north 28,260 ft.) and the lowest elevation in the south (700 ft.). The rainy season starts in May. The annual rainfall is about 80 inches in the western Sikkim and in eastern Sikkim about 150–180 inches are usually recorded.

Though some work has been undertaken on lichens (Chopra, 1932 ; Taylor, 1847) and Hymenomycetous fungi (Banerjee and Ghosh 1945) of this region, nothing has yet been published on plant diseases of Sikkim. The author visited Sikkim during September and October, 1960, for, carrying out a survey of wart disease of potato, when he also collected some specimens of diseased plants in order to have some idea about their occurence and distribution there.

Plant specimens of the diseases, recorded in this paper have been deposited in the Mycology Herbarium of the Plant Quarantine and Fumigation Station of the Government of India, at Calcutta.

FUNGOUS DISEASES

Phycomycetes :

1. *Albugo candidus* (Pers.) Lev. (Sacc.* VII : 334 ; B. and B : 3**).

On the living leaves of *Raphanus sativus* L. (Cruciferae) Gangtok vegetable market, 9-9-60, Leg N. C. J., Mycol. Herb. No. 1 (conidial stage).

2. *Albugo bliti* (Biv.) De Bary (Sacc. VII : 236 ; B. and B. : 2).

On the living leaves of *Amarantus paniculatus* L. (Amarantaceae), Nayabazar, 10-9-60, Leg N. C. J., Mycol. Herb. No. 2 (conidial stage).

3. *Albugo portulacae* (D. C.) Leville (Sacc. VII : 236 ; B. and B : 2).

On the living leaves of *Portulaca oleraceae* L. (Portulacaceae), Nayabazar, 10-9-60, Leg N. C. J., Mycol. Herb. No. 3 (conidial stage).

4. *Albugo platensis* Speg. (Sacc. XI : 242 ; B. and B : 3).

On the living leaves of *Boerhaevia diffusa* L. (Nyctaginaceae), Nayabazar, 10-10-60 Leg N. C. J., Mycol Herb. No. 4 (conidial stage).

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*Saccardo, P. A. (1882–1931) *Sylloge fungorum omnium hucusque cognitorum.*
**Butler, E. J. and Bisby, G. R. (1930). *The fungi of India*, I. C. A. R., Sci ; Mono.

5. *Pyhtophthora colocasiae* Raciborski (Sacc. XVI : 292 ; B. and B : 5).

On the living leave of *Colocasia antiquarum* Scott. (Araceae) Gangtok, 9-9-60, Leg N. C. J., Mycol. Herb. No. 5 (conidial stage).

6. *Phytophthora infestans* De Bary (Sacc. VII : 237 ; B. and B : 5).

In tubers of *Solanum tuberosum* (Solanaceae), Rangpoo, 10-9-60, Leg N. C. J., Mycol. Herb. No. 6 (conidial stage).

7. *Pythium artotrogus* (Mont.) De Bary (Sacc. XI : 244 ; B. and B : 7)

In rotting tubers of *Solanum tuberosum* (Solanaceae), Rangpoo, 10-9-60, Leg N. C. J., Mycol. Herb. No. 7 (conidial stage).

8. *Peronospora brassicae* Gaumann (Sacc. XXIV : 45, Mudkur, 1938).

On the living leaves of *Raphanus sativus* L. (Cruciferae), Gangtok, 9-9-60, Leg N. C. J., Mycol Herb. No. 8 (conidial stage).

Ascomycetes :

9. *Capnodium citri* Berk and Desem. (Sacc. i : 78, Mundhkur : 12).

On the living leaves of *Citrus* sp. (Myrtaceae), Gangtok, 10-9-60, Leg N. C. J., Mycol. Herb. No. 9 (conidial) stage).

10. *Capnodium anonae* Patouill (Sacc. XVII : 555 ; B. and B : 18).

On the living leaves and twigs of *Ficus bengalensis* (Moraceae), Rangpoo, 10-9-60, Leg N. C. J., Mycol. Herb. 10 (conidial stage).

11. *Meliola cameliae* (Catt.) (Sacc. 1 : 62 ; B. and B : 28).

On the living leaves of *Citrus* sp. (Myrtaceae), Gangtok, 11-9-60, Leg N. C. J., Mycol. Herb. No. 11 (conidial stage).

12. *Erysiphe polygoni* D. C. (Sacc. 1 : 19 ; B. and B : 22)

On the living leaves of *Rumex* sp. (Polygonaceae), 11-10-60, Namchi, Leg N. C. J., Mycol. Herb. No. 12 (conidial and perithecial stages).

13. *Phyllactinia corylea* (Pers.) Karnst (Sacc. 1 : 5 ; B. and B : 35).

On the living leaves of *Pyrus* sp. (Rosaceae), Gangtok, 9-9-60, Leg N. C. J., Mycol. Herb. No. 13 (conidial and perithecial stages).

14. *Sphaerotheca euphorbiae* (Cast). Salmon (Sacc. XIV : 462).

On old leaves of *Euphorbia* sp. (Euphorbiaceae), Namchi, 11-9-60, Leg N. C. J, Mycol. Herb. No. 15 (conidial and perithecial stages).

15. *Sphaerotheca pannosa* (Wallr.) Lev. (Sacc. 1 : 3 ; B. and B : 39).

On old leaves of *Rosa* sp. (Rosaceae), Gangtok, 10-9-60, Leg N. C. J., Mycol. Herb. No. 16 (conidial and perithecial stages).

16. *Phyllachora cynodontis* (Sacc.) Niessl (Sacc. XI : 602 ; B. and B : 33).

On the living leaves of *Cynodon dactylon* (Gramineae), Gangtok, 10-9-60, Leg N. C. J., Mycol. Herb No. 13 (Perithecial stage).

17. *Phyllachora graminis* (Pers.) Fckl (Sacc. XI : 602 ; B. and B : 33).

On the living leaves of *Chloris barbata* (Gramineae), Namchi, 11-9-60, Leg N. C. J., Mycol. Herb. No. 14 (perithecial stage).

Basidiomycetes :

18. *Entyloma oryzae* Syd. (Sacc. XXII : 625 ; B. and B : 44).

On the living leaves of *Oryza sativa* (Gramineae), 10-9-60, Leg N. C. J., Mycol. Herb. No. 18 (teliospores abundantly present).

19. *Entyloma dahliae* Syd. (Green, 1932 ; Joshi, 1960).

In the living leaves of *Dahlia* sp. (Compositeae), Gangtok, 9-9-60, Leg N. C. J., Mycol. Herb. No. 19 (teliospores abundantly present).

20. *Sphacelotheca fagopyri* Syd. and Butler (Sacc. XXI : 508 ; B. and B : 46)

In the ovaries of *Fagopyrum esculentum* (Polygonaceae), Namchi 11-9-60, Leg N. C. J., Mycol. Herb. No. 20 (teliospores abundantly present).

21. *Melampsora helioscopiae* (Pers) Wint. (Sacc. VII : 586 ; B. and B : 60).

On the living leaves of *Euphorbia* sp. (Euphorbiaceae), Nayabazar, 10-9-60, Leg N. C. J., Mycol. Herb. No. 21 (uredial and telial stages).

22. *Puccinia cynodontis* Desm. (Sacc. VII : 61 ; B. and B : 66).

On the living leaves of *Cynodon dactylon* (Gramineae), Namchi, 11-9-60, Leg N. C. J. Mycol. Herb. 22 (uredial and telial stages).

23. *Puccinia fagopyri* Barclay (Sacc. IX : 306 ; B. and B : 67).

On the living leaves of *Fagopyrum esculentum* (Polygonaceae) Namchi, 11-9-60, Leg N. C. J., Mycol. Herb. No. 23 (uredial and telial stages).

24. *Uromyces andropogonis-annulati* Syd. and Butler (Sacc. XXI : 592 ; B. and B : 80).

On the living leaves of *Andropogon annulatus* (Gramineae), Gangtok, 9-9-60, Leg N. C. J., Mycol. Herb. No. 24 (uredial and telial stages).

25. *Uromyces commelinae* Cke. (Sacc. VII : 573 ; B. and B : 81).

On the living leaves of *Commelina bengalensis* (Commelinaceae), Nayabazar, 10-9-60, Leg N. C. J., Mycol. Herb. No. 25 (uredial and telial stages).

26. *Uromyces appendiculatus* (Pers) Link (Sacc. VII : 535 ; B. and B : 81).

On the living leaves and stem of *Phaseolus* sp. (Leguminoseae Namchi, Leg N. C. J., 11-9-60, Mycol. Herb. No. 26 (uredial and telial stages).

27. *Uromyces hobsoni* Vize (Sacc. VII : 583 ; B. and B : 82).

On the living leaves and stem of *Jasminum* sp. (Oleaceae), Namchi, 11-9-60, Leg N. C. J., Mycol. Herb. No. 27 (telial stage).

Deuteromycetes :

28. *Actinomyces scabies* (Thaxter) Gussow (Sacc. IV : 526 ; B. and B : 139).

On the tubers of *Solanum tuberosum* (Solanaceae), Damthan, 12-9-60, Leg N. C. J., Mycol. Herb. No. 34.

29. *Alternaria brassicae* (Berk) Balle (B. and B : 139).

On the living leaves of *Brassica* sp. (Cruciferae), Gangtok, 10-9-60. Leg N. C. J., Mycol. Herb. No. 35.

30. *Alternaria citri* Pierce (Sacc. XVIII : 629 ; Mundkur : 30).

On living leaves of *Citrus* sp. (Myrtaceae), Rangpoo, 9-9-60, Leg N. C. J., Mycol. Herb. No. 36.

31. *Cercospora oryzae* Miyake (Sacc. XXII : 1431 ; B. and B : 143).

On the living leaves of *Oryza sativa* (Gramineae), Melli, 11-9-60, Leg N. C. J., Mycol. Herb. No. 37.

32. *Cercospora solanacea* Sacc. (Sacc. IV : 449 ; B. and B : 143).

On the living leaves of *Solanum melongena* L. (Solanaceae), Gangtok, 10-9-60, Leg N. C. J., Mycol. Herb. No. 38.

33. *Fusarium oxysporum* Schlecht (Sacc. IV : 705 ; B. and B : 146).

On tubers of *Solanum tuberosum* (Solanaceae), Rangpoo, 9-9-60 Leg N. C. J., Mycol. Herb. No. 39.

34. *Helminthosporium oryzae* Breda de Haan (Sacc. XXII : 1394 ; B. and B : 147).

On the living leaves of *Oryza sativa* (Gramineae), 10-9-60, Leg N. C. J., Mycol. Herb. No. 40.

35. *Penicillium expansum* Thom. (Mundkur : 36).

Isolated from a diseased apple, Gangtok fruit market, 9-9-60, Leg N. C. J., Mycol. Herb. No. 41.

36. *Colletotrichum gloeosporiodes* Penzig (Sacc. iii : 735 ; B. and B : 153).

On twigs of *Citrus aurantium* (Myrtaceae), Gangtok, 9-9-60, Leg N. C. J., Mycol. Herb. No. 42 (a serious anthracnose disease of Citrus in Sikkim).

37. *Colletotrichum lindemuthianum* (Sacc. and Mag.) Br. and Cav. (B. and B : 153).

On the living leaves of *Phaseolus vulgaris* (Leguminosae), Gangtok, 10-9-60, Leg N. C. J., Mycol. Herb. No. 43.

38. *Macrophomina phaseoli* (Maubl) Ashby (B. and B : 158).

On tubers of *Solanum tuberosum* (Solanaceae), Namchi, 12-9-60, Leg N. C. J., Mycol. Herb. No. 45.

39. *Colletotrichum dracaenae-fragrantis* (Mori) Petr and Syd. (Mundkur : 38).

On the living leaves of *Dracana* sp. (Liliaceae), Rangpoo, 10-9-60, Leg N. C. J., Mycol. Herb. No. 44.

40. *Septoria rosae* Desmoz (Sacc. iii ; 485 ; B. and B : 164).

On the living leaves of *Rosa* sp. (Rosaceae), Gangtok, 12-9-60, Leg N. C. J., Mycol. Herb. No. 46.

Bacterial Diseases :

41. *Pseudomonas solanacearum* (E. F. Smith) E. F. Smith (Mundkur, 1949).

In tubers of *Solanum tuberosum* (Solanaceae), Rangpoo, 10-9-60, Leg N. C. J., Mycol. Herb. No. 47.

42 *Xanthomonas* citri (Hass) Dowson (Mundkur, 1949).

On leaves and fruits of *Citrus* sp. (Myrtaceae), Gangtok, 10-9-60, Mycol. Herb. No. 48. (This pathogen causes citrus canker ard is becoming a serious disease of citrus in Sikkim).

Virus Diseases :

43. *Virus* (Anon., 1933).

On the living plants of *Amomum subulatum* (Zinziberaceae), Rongli, 18-10-60., Leg N. C. J., Mycol. Herb. No. 49.

This is a serious virus disease on large cardamom, which is commonly called here as 'Foorkey' disease by local people. The disease is prevalent through out in Eastern Sikkim.

SUMMARY

40 fungi, two bacteria and one virus have been reported in this paper. Among the fungi, eight are Phycomycetes, nine Ascomycetes, ten Basidiomycetes and 13 Deuteromycetes. The virus disease on Cardamom (*Amomum subulatum*) which is commonly called 'Foorkey' disease by the local people in Sikkim and West Bengal is of great economic importance.

ACKNOWLEDGMENT

I am grateful to Dr. K. B. Lal, Plant Protection Adviser to the Government of India who allowed me to publish this paper. I am also grateful to Dr. P. R. Mehta, Deputy Director Plant Diseases, Directorate of Plant Protection, Quarantine and Storage, New Delhi for kindly going through the manuscript and his valuable suggestions.

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*Original not seen.

STUDIES ON NEW GALL MIDGE (CECIDOMYIIDAE : NEMATOCERA : DIPTERA) FROM INDIA V

By

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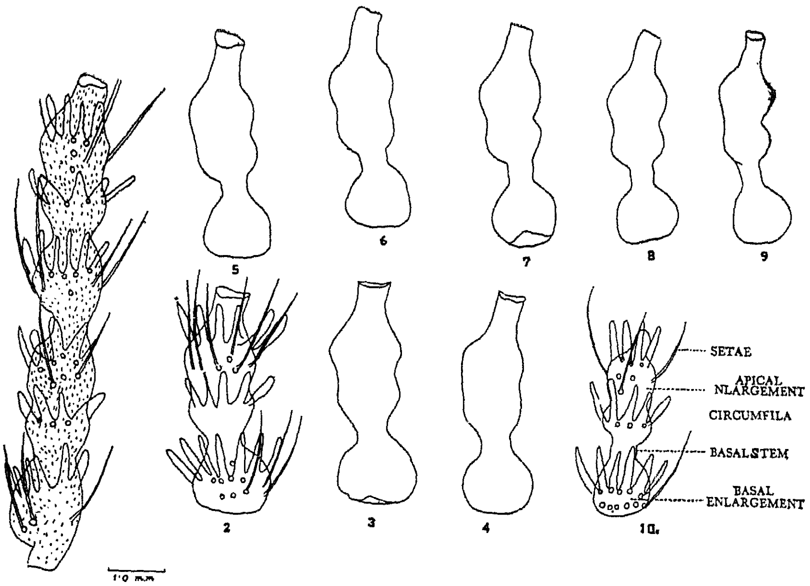
Subfamily *Itonididinae*

Tribe *Trifilini*

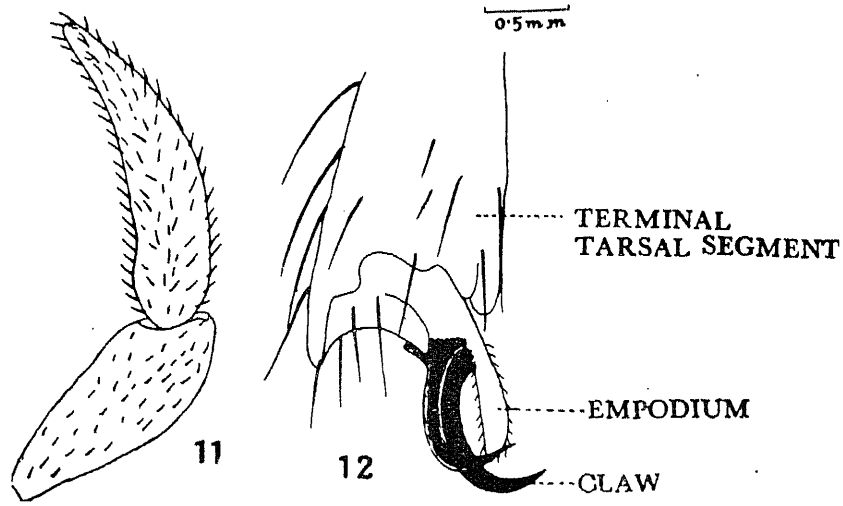
Dyodiplosis glomeratаii sp. nov.

Male : Body 1·6 mm. long, dark-brown. **Head** : *Eyes* confluent above, trophi normal ; *palpi* (Fig. 11) triarticulate, light-brown sparsely setose ; first segment not clearly visible in the preparation ; the second segment short, broad sub-apically, length two-and-two-third the maximum thickness ; third segment long, one and one-fourth times longer than the second segment and four times as long as broad, tapering towards the apex, broad basally. *Antenna* dark-brown, slightly longer than the body, with 14 segments, segments binodose, but the apical enlargement with slight constriction in the middle, giving a false appearance of trinodose structure ; circumfila in three whorls, regular, and equal in length ; basal enlargement with one whorl of circumfila and one whorl of long setae, apical enlargement with two whorls of circumfila and one whorl of long setae, basal enlargement shorter than the apical ; apical stem longer than the basal ; the third antennal segment fused with the fourth ; scape and pedicel not visible in the preparation ; third segment (Fig 1) fused with the fourth and longer than the latter, with short basal prolongation, nearly one-eleventh the length of the segment and two-third as long as thick, basal enlargement a little less than one-third the length of the segment and one-and-one-third as long as thick, basal stem very short, apical enlargement longer than the basal, a little more than half the length of segment and nearly twice as long as thick, apical stem one-fifth the length of the apical enlargement and wider than long ; fourth segment (Fig. 1) shorter than the third, basal enlargement globose and a little over one-third the length of the segment, basal stem one-fifth the basal enlargement and nearly one-third as long as thick, apical enlargement nearly half the length of the segment, longer than the basal enlargement and one and one-seventh times as long as thick, apical stem longer than the basal, one-fourth the length of the apical enlargement and as long as thick ; sixth segment (Fig. 2) shorter than the fifth, basal enlargement a little more than one-third the length of the segment and slightly wider than long, sub-globose, basal stem shorter nearly one-seventh the basal enlargement and one-third times as long as thick, apical enlargement longer than the basal, slightly more than one-half the length of the segment and nearly one-and-a-half times as long as thick, apical stem nearly one-third the apical enlargement and as long as thick ; seventh segment (Fig. 3) similar to the sixth segment ; eighth segment (Fig. 4) slightly shorter than the seventh segment, basal enlargement slightly more than one-third the length of the segment and wider than long, basal stem a little more than one-fourth the basal enlargement and one-half times as long as thick, apical enlargement slightly more than one-half the length of the segment and longer than the basal enlargement, one-and-one-third times as long as thick, apical stem two-fifth the apical enlargement and one and-one-third times as long as thick ; ninth segment (Fig. 5) as long as eighth



Text-figures 1—10 showing the structure of antennal segments of *Dycdiplosis glomeratai*. 1. Third and fourth antennal segmens of male. 2. Sixth antennal segment of male. 3. Seventh antennal segment of male. 4. Eighth antennal segment of male. 5. Ninth antennal segment of male. 6. Tenth antennal segment of male. 7. Eleventh antennal segment of male. 8. Twelfth antennal segment of male. 9. Penultimate antennal segment of male. 10. Terminal antennal segment of male.

segment, basal enlargement nearly one-fourth the length of the segment and four-fifth as long as thick, basal stem one-third the basal enlargement and two-third as long as thick, apical enlargement a little more than one-half the length of the segment and one-and-a-half times as long as thick, apical stem one-fourth the length of the apical enlargement and one-and-a-half times as long as thick ; tenth segment (Fig. 6) similar to the ninth except the apical enlargement which is shorter and narrower than that of the ninth segment ; eleventh segment (Fig. 7) as long as ninth segment, basal enlargement slightly narrower than that of the ninth segment, basal stem slighty longer than one-half the length of the basal enlargement and as long as thick, apical enlargement slightly shorter than that of the ninth segment ; twelfth segment (Fig. 8) as long as the tenth segment, slightly shorter but similar to the eleventh segment except the apical stem ; penultimate segment (Fig. 9) similar to the twelfth segment except the width of the enlargements slightly narrow, apical stem twice as long as thick ; terminal segment (Fig. 10) short, globose, basal enlargement a little over one-third the length of the segment, basal stem a little more than one-half the length of the enlargement and as long as thick, apical enlargement a little over one-half the length of the segment and nearly twice as long as thick, apical knob one-tenth the length of the segment and as long as thick.
Thorax: *Mesonotum* dark-brown, scutellum and post-scutellum pale-brown. *Wing* (Fig. 13) hyaline, nearly two-and-a-half times as long as broad, vein R_s absent, vein R_5 uniting with costa much beyond the apex of the wing and curved, vein M_{1+2} present and complete, vein *Cu* forked ; *Legs* long densely hairy, dark-brown, metatarsal as long as terminal tarsal segment and shorter than the second tarsal segment, second tarsal segment less than eight times the metatarsal segment, third tarsal



Text-figures 11—12 showing the structu e of palpus and hind claw. 11. Palpus. 12. Hind claw.

segment nearly one-third the length of the second tarsal segment ; claw (Fig. 12) dark-brown and bent at right angle, simple, empodium slightly shorter than the claw. **Abdomen** yellowish-brown. *Genitalia* (Fig. 14A) dark-brown to light-brown, moderately setose, basal clasp segment stout, with small projections, broad sub-apically, length nearly two–and-one-third its maximum thickness, terminal clasp segment short, stout, widened basally, gradually tapering up to the middle, ending in a blunt tooth and bidentate below, slightly over twice the maximum thickness, dorsal plate as long as broad, broadly and narrowly incised in the middle, lobes bluntly rounded, ventral plate longer than the dorsal, length one and three-fifth the maximum thickness, emarginate laterally, broadly incised, lobes rounded divergent and strongly emarginate, style short, shorter than the dorsal and ventral plates, globose basally, length five times its maximum thickness.

Holotype :

One male dissected and mounted on one slide, labelled "gular", reared from the gall on the leaves of *Ficus glomerata*, dated 24th March, 1961.

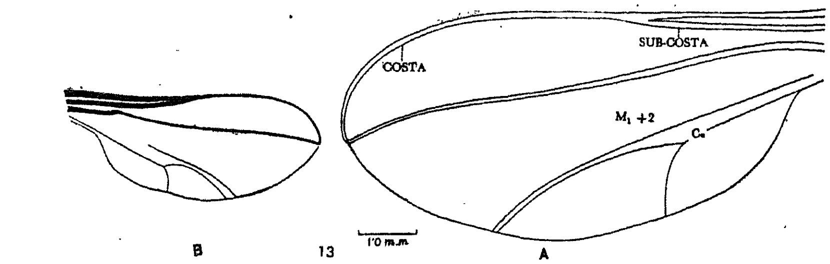
Paratype :

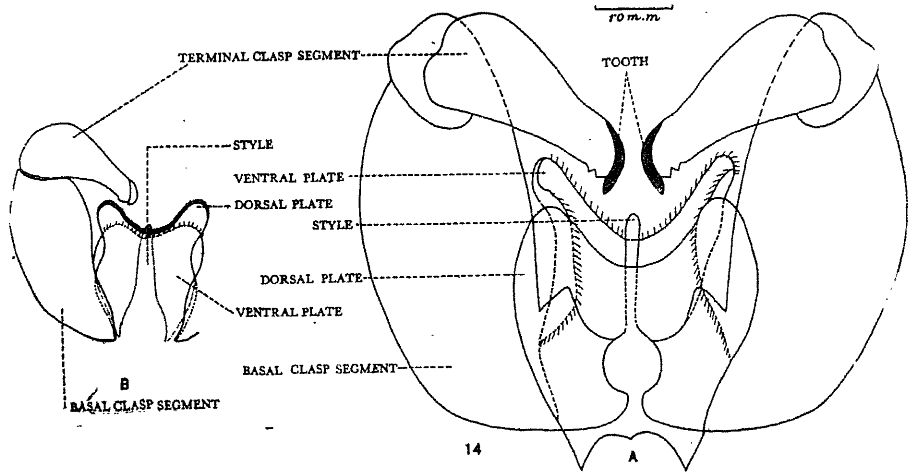
One male dissected and mounted on one slide and labelled as "gular."

DISCUSSION

This note describes the first record of a new species of the genus *Dyodiplosis* reared from the leaves of *Ficus glomerata* Roxb. from Allahabad. The genus *Dyodiplosis* was created by Rübssamen in 1912. Felt in 1921 described seven species namely *D. generosi, D. andropoginis, D. cornea, D. fluvialis, D. indica, D. monticola* and *D. plumosa* breeding o grasses from India. Rao 1949 described *D. fici* from the galls of *Ficus glomerata* Roxb. from Agra. It has also been recorded from Calcutta, Banares, Agra, Nellore (Madras).

The present species can be easily distinguished from *D. fici* by a comparative study of the genitalia, wing, palpal and antennal segments.





Text-figures 13 and 14. 13 A. Wing of *D. glomeratii* ; B. Wing of *D. fici*. 14 A. Genitalia of *D. glomeratii* ; B, genitalia of *D. fici*.

Genitalia :

Basal clasp segment of *D. glomerataii* is provided with a short triangular projection, whereas, in *D. fici* the basal lobe is absent. Terminal clasp segment of *D. glomerataii* is a little more than twice the length of the basal clasp segment, enlarged basally and tapering abruptly upto the middle ; terminally it is furnished with a large apical tooth below which occur two dents, whereas, in *D. fici* (Fig. 14 B) the terminal clasp segment is two-third the length of the basal clasp segment, enlarged basally, tapering gradually upto the tip and terminally it is pectinate ; ventral plate in the latter is narrow, longer than the dorsal plate and is incised broadly and shallowly in the middle. Lobes are bluntly pointed at the apex and laterally each is strongly emarginate, while, in the *D. fici* the ventral plate is as long as or may be shorter than the dorsal plate. It is broadly incised in the middle and the lobes are rounded apically. Apical margins are conspicuously fringed with short stiff setae. Dorsal plate is one-and-six-seventh the length of the basal clasp segment and is shallowly incised in the middle with broadly rounded lobes apically in *D. glomerataii*, whereas, in *D. fici* the dorsal plate is three-fourth the length of the basal clasp segment and is broadly incised in the middle with very bluntly pointed lobes. Sides are emarginate strongly. Style in the case of *D. glomerataii* is slender and slightly broad apically. It is shorter than the ventral plate, whereas, in *D.*

fici the style is stout, as long as or slightly shorter than the dorsal plate, distinctly bulging at the basal half.

Wing :

In *D. glomeralaii* the wing is two-and-a-half times as long as broad, whereas, in *D. fici* it is two and three-fourth times as long as broad. In the latter vein M_{1+2} is complete and distinct but in the former it is faint and incomplete.

Antenna :

Third antennal segment is longer than the fourth in *D. glomeralaii* and in *D. fici* third antennal segment is shorter than the fourth. Similarly rest of the antennal segments of *D. glomeralaii* differ in proportion with the antennal segments of *D. fici*. Same is the case with the palpal segments.

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STUDIES ON TREMATODE PARASITES OF INDIAN BIRDS II. ON *STEPHANOPRORA GIGANTICA* SP. NOV. FROM THE BLACK-NECKED STORK, *XENORHYNCHUS ASIATICUS* (LATHAM)

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[Received on 22nd December, 1961]

Fifty-two specimens of an interesting echinostome parasite, which is described in the present paper, were collected from the intestine of the Black-necked Stork, *Xenorhynchus asiaticus* (Latham), shot by the writer in the environs of Anupshahr, Hardoi, and Lucknow in the State of Uttar Pradesh.

The body (Fig. 1) of the parasite is exceedingly long and slender, measuring 22·500–26·764 mm. in length and 1·395–1·689 mm. in maximum breadth in the region of the ventral sucker. Behind this region the body is almost of a uniform breadth. The cuticle bears minute spines upto the pre-ovarian region.

The cephalic collar is well developed and armed with twenty-two spines which are arranged in a single, dorsally broken row. The collar spines measure 0·064–0·091 mm. by 0·018–0·023 mm. The terminal oral sucker measures 0·154–0·210 mm. by 0·210–0·238 mm. The ventral sucker is situated at about the middle of anterior third of body and measures 0·476–0·574 mm. by 0·476–0·532 mm.

The mouth leads into a short prepharynx, measuring 0·056–0·098 mm. in length. The pharynx is elliptical and larger than oral sucker, measuring 0·252–0·308 mm. by 0·164–0·214 mm. The oesophagus is long and slender, measuring 2·437–3·001 mm. in length. It is surrounded by a thick coat of small and compact gland cells (Figs. 1, 2, 3) and bifurcates into the intestinal caeca at about 0·350–0·631 mm. in front of the ventral sucker. The caeca run upto the hind end of body.

The testes are tandem and closely placed in anterior region of the middle third of body. They are quadrangular or oval in shape. The anterior testis measures 1·010–1·540 mm. by 0·812–0·994 mm., while the posterior one measures 1·204–1·582 mm. by 0·771–0·980 mm. The cirrus sac is a pear-shaped structure (Fig. 3), extending back from the common genital pore upto the middle level of ventral sucker. It measures 0·602–0·840 mm. by 0·238–0·406 mm. and encloses a large bipartite seminal vesicle, a short pars prostatica and a short ejaculatory duct. The terminal part of the ejaculatory duct passes through an eversible cirrus which is spiny. The common genital pore is median or submedian and situated immediately behind the intestinal bifurcation.

The ovary (Figs. 1, 4) is median and situated just in front of the anterior testis. It is a trilobed structure, measuring 0·294–0·420 mm. by 0·532–0·616 mm. The vitellaria are composed of small follicles which extend back along the lateral regions of body from the level of ovary upto the posterior end. The vitelline reservoir and the Mehlis' gland are situated just behind the ovary (Fig. 4). The Laurer's canal is present. A true receptaculum seminis is absent, but the proximal part of the uterus contains sperms and thus forms a receptaculum seminis uterinum (Fig. 4). The uterus consists of several transverse coils which are confined to the

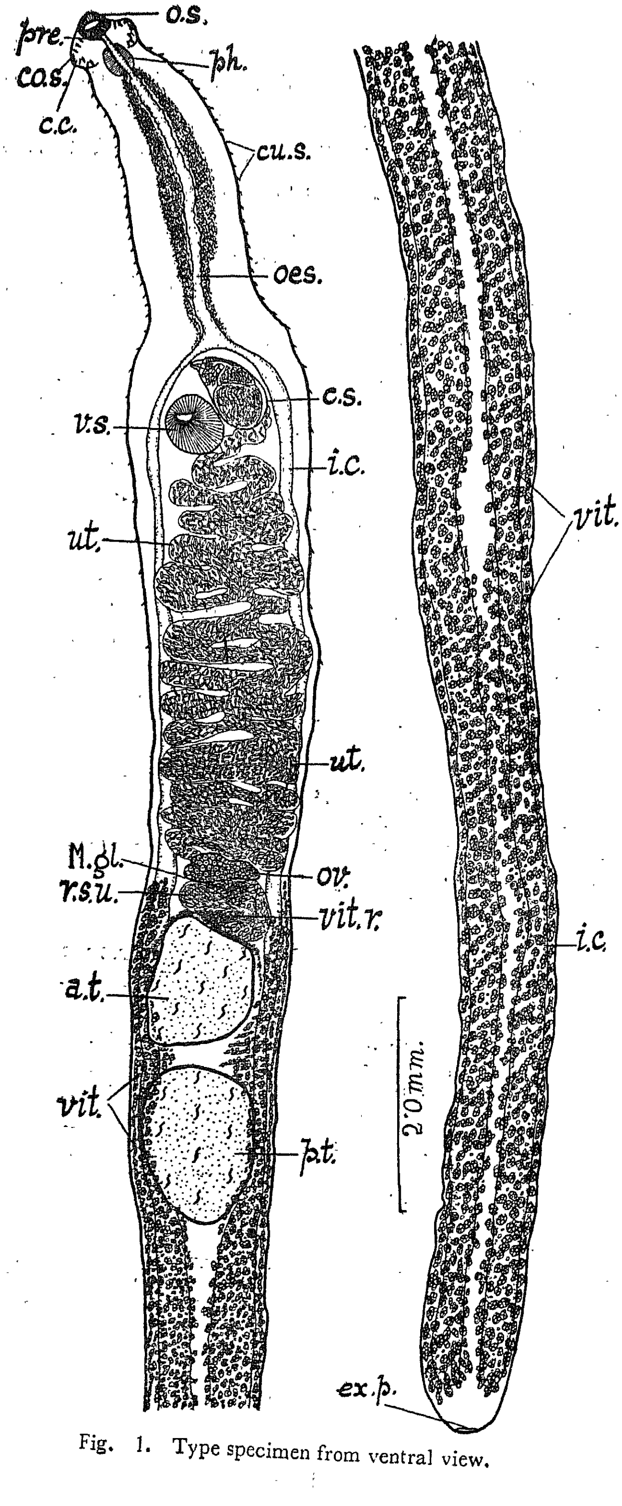

Fig. 1. Type specimen from ventral view.

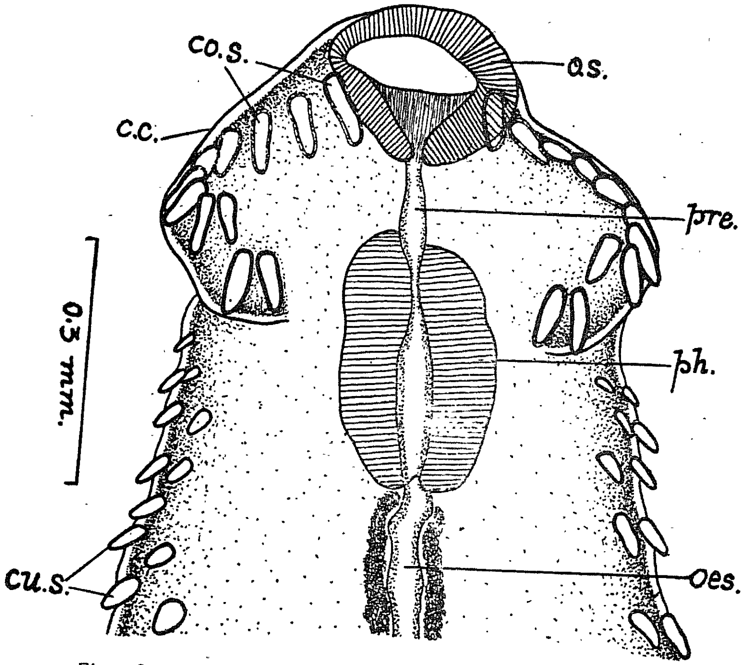

Fig. 2. Anterior end of type specimen enlarged (ventral·view).

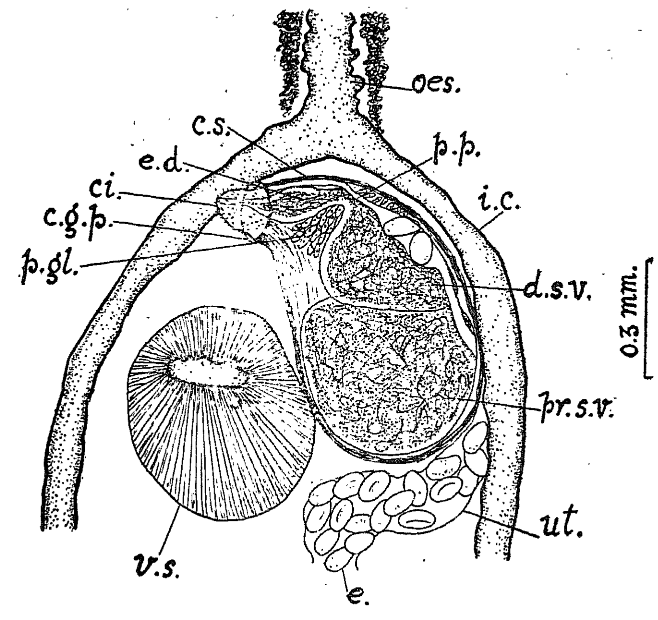

Fig. 3. Acetabular region of type specimen enlarged (ventral view).

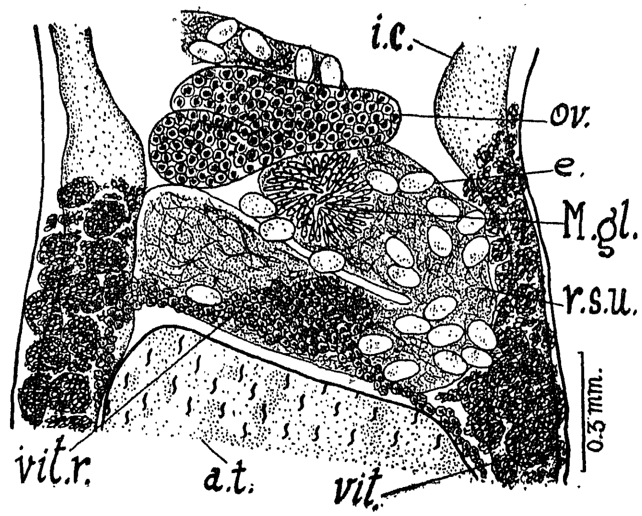

Fig. 4. Ovarian region of type specimen enlarged (ventral view).

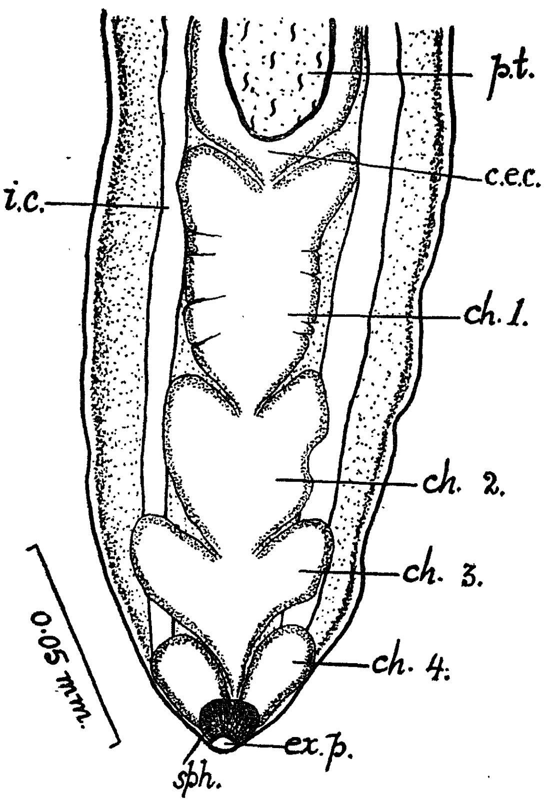

Fig. 5. Excretory bladder drawn from a young specimen in living condition.

region between testes and ventral sucker. It contains numerous oval and operculate eggs which measure 0·0945–0·1002 mm. by 0·0535–0·0628 mm.

The excretory system was studied in living young specimens. The excretory bladder is divided into four chambers (Fig. 5). The anterior chamber of the bladder receives the short common excretory cornu, formed by the union of two lateral cornua. The last chamber of the bladder seems to have muscular sphincter. The excretory pore is terminal.

DISCUSSION

The genus *Stephanoprora* Odhner, 1902 includes twenty-five species. The present form can be distinguished from all these species by its trilobed ovary, by its thick coat of gland cells around the oesophagus, and by its chambered excretory bladder. Moreover, the extremely long size of this form separates it from all other species. Even in the entire subfamily *Echinochasminae* Odhner, 1911, to which *Stephanoprora* belongs, no species of the size of the present form is yet described.

Evidently, the present form represents a new species of the genus *Stephanoprora* Odhner, and is named as *Stephanoprora gigantica.*

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Author's sincere thanks are due to Prof. M. B. Lal of Lucknow University for his guidance, and to Dr. S. C. Baugh for his valuable help throughout the progress of this work.

LETTERING

a.t.—anterior testis ; c.c.—cephalic collar ; c.e.c.—common excretory cornu ; c.g.p.—common genital pore ; ch 1, 2, 3, 4—chambers of excretory bladder ; ci.—cirrus ; co.s.—collar spines ; c.s.—cirrus sac ; cu.s.—cuticular spines ; d.s.v.—distal part of seminal vesicle ; e.—eggs ; e.d.—ejaculatory duct ; ex.p.—excretory pore ; g.—gland cells ; i.c.—intestinal caeca ; M.gl —Mehlis' gland ; oes.—oesophagus ; o.s —oral sucker ; ov.—ovary ; ph.—pharynx ; pre.—prepharynx ; p.t.—posterior testis ; p.gl.—prostatic gland ; p.p.—pars prostatica ; pr.s.v.—proximal part of seminal vesicle ; r.s.u.—receptaculum seminis uterinum ; ut —uterus ; vit.—vitelline follicles ; vit.r.—vitelline reservoir ; v.s.—ventral sucker ; sph.—sphincter.

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TOP NECROSIS OF CYAMOPSIS TETRAGONOLOBA (L.) TAUB.

By

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Cyamopsis tetragonoloba (L.) Taub. (Guar) is widely cultivated in India and is used as a food and forage crop. Since 1956 guar plants grown near about Lucknow were found affected by top necrosis in several fields. Initially 10% of the plants developed disease symptoms which appear every year during late July and by the beginning of September, about 90% of the plants in fields show definite symptoms of the disease. The rapid increase in the number of affected plants might be due to two factors. Either the plants which developed the disease later had been previously carrying the virus in a masked condition, or there might have been an increase in transmission by some insect vector so far not known to us.

MATERIALS AND METHODS

Leaves of guar infected with the virus were crushed with sterile distilled water which was added in the proportion of 1 ml. of distilled water to 1 g. of leaf material. The sap was expressed, passed through muslin cloth and centrifuged at 3,000 r.p.m. for 15 minutes. The supernatant was carefully decanted and used as inoculum. Vigorously growing young plants (See Table I) were inoculated and kept in insect proof cages. Carborundum powder was used as an abrasive.

RESULTS

The disease was successfully transmitted by means of mechanical inoculations but could not be transmitted by *Bemisia tabaci*, *Myzus persicae* and *Aphis gossypii*.

Host range :

On guar the disease symptoms appeared after a week as light chlorotic mottling and yellowing of leaves (Plate I, Fig. 3). On careful observation of the leaflets, small chlorotic depressions were also observed which later became necrotic. The main characteristic of the disease was bronzing which in most cases started on the lower surface of the leaflets and subsequently spread down the petioles to the main stem (Plate I Fig. 1). As the season advanced, the bronzing was so much pronounced as to give the upper part of the plant a burnt appearance. Later, there was a necrosis of the stem and the growing points. The young leaflets beganto shed and finally a bare stem was left with some bronze-coloured curled leav es (Plate I, Fig. 2). These symptoms resulted in the ultimate death of the plant. A few plants showed milder symptoms following non-lethal necrosis with mottling, leaf-distortion and stunted growth.

The symptoms which developed in host plants by mechanical transmission, other than guar, are summarised in Table I.

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TABLE 1

Summary of the symptoms developing on host plants belonging to two different families

Family	Host plant	Characteristic symptoms
I. Leguminosae	1. *Phaseolus vulgaris* L. (Bean)	The symptoms consisted of a light chlorotic mottling and sometimes a very mild necrotic stipple.
	2. *Phaseolus aureus* Roxb. (Mungbean)	On rubbing the cotyledonary leaves with infected sap no visible symptoms appeared on the inoculated leaves except slight chlorosis and scorching. New leaves which emerged after inoculation curled and became necrotic. Later the plants developed terminal necrosis on account of which the plant growth was drastically reduced (Plate II, Fig. 1).
Leguminosae	3 *Soja max* Piper (Soybean)	This plant also reacted like mungbean and developed necrosis starting from the tips and margins of the young leaves a week after inoculation (Plate II, Fig. 2).
	4. *Vigna sinensis* Endl (Cowpea)	Chlorotic local lesions were observed on this plant. Sometimes the lesion development was masked.
II. Solanaceae	5. *Petunia hybrida* Vilm (Petunia)	No visual symptoms were observed on the leaves after inoculation for a long time. Later slight mottling was observed. The recovery of virus was successfully achieved on sub-inoculation.
	6. *Datura stramonium* L. (Common Thornapple)	Small chlorotic areas followed by a systemic spread of the virus in the leaves which developed light chlorotic mottling were observed. At a later stage the leaves became leathery, rough and occasionally curled.
	7. *Solanum nigrum* L. (Nightshade)	Developed mild mosaic mottling on the leaves.
	8. *Nicotiana tabacum* L. var. White Burley (Tobacco)	Necrotic lesions developed on the leaves a week after inoculation.

Following plant species did not develop any symptoms of the disease. The recovery of the virus also was not achieved on sub-inoculation :

PLATE I

Fig. 1. *Cyamopsis tetragonoloba* (L.) Taub. showing the bronzing of leaves and blackened necrotic stem
Fig. 2. Late stage in top necrosis. Note the defoliation, curled young leaves and necrotic depressions on the older foliage.

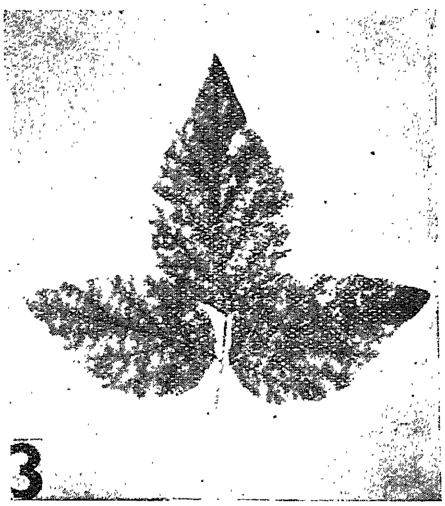

Fig. 3. Leaflets showing chlorotic mottling.

PLATE II

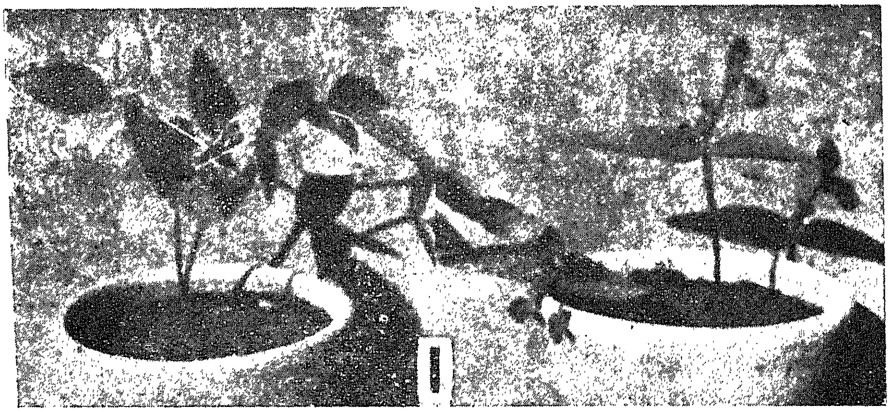

Fig. 1. Diseased (right) and healthy (left) mungbean plants. Curling of leaflets, terminal necrosis and stunted growth of diseased plant are clearly visible.

Fig. 2. Diseased (right) and healthy (left) soybean plants. Note the curling and necrosis of the leaflets in diseased plant.

Lycopersicon esculentum Mill. (Tomato) ; *Capsicum frutescens* L. (Chillies) ; *Nicotiana tabacum* L. var. Turkish (Tobacco) ; *N. glutinosa* L. *Dolichos lablab* L. (Bean) ; *Pisum sativum* L. (Pea) ; *P. arvens* L *Vicia faba* L. (Broad bean). *Brassica oleraceae* L. (Cabbage/cauliflower) ; *Raphanus sativus* L. (radish). *Beta vulgaris* L. (Sugar beet); *Vinca rosea* L. (Blue Periwinkle) ; *Antirrhinum majus* L. (Snapdragon) ; *Cucumis sativus* L. (Gourd) ; *Lagenaria* spp. *Zinnia elegans* Jacq. (Zinnia) ; *Callistephus chinensis* Nees ; *Calendula* spp. (Marigold).

Physical properties :

Dilution end point.—The virus in crude sap withstood a dilution of 1 : 1000.

Thermal death point.—This was determined by heating 2 ml. aliquots of expressed sap on a water bath at various temperatures for 10 minutes. The infectivity started to decrease beyond 45°C. Experiments indicated that the thermal death point of the virus was about 70°C.

Longevity *in Vitro.*—The virus retained infectivity in expressed sap after aging for 6 days at room temperature (25-30°C) but was inactivated after 7 days.

Histopathology :

Transverse sections of the leaflets at every stage of necrosis revealed that the necrosis actually started superficially on the epidermal cells, later spreading into the mesophyll region. Similarly in petiole and the stem the necrosis was limited to the epidermal and hypodermal cells. The sections failed to show any necrosis in the phloem tissue at any stage of the disease.

Acquired immunity :

Almost 80% of the plants after reacting initially with an actually necrotic disease later produced new leaves which were apparently healthy and showed no symptoms of the necrotic disease. Inoculation experiments from these apparently healthy leaves positively confirmed the presence of virus. When the sap from recovered leaves was inoculated on healthy guar plants usual symptoms of the disease were produced. Recovery of the plants was so complete that it was difficult to distinguish between healthy and diseased plants in the same field. The sequence of an acute initial reaction followed by a later chronic stage is common to a number of virus diseases, especially those with symptoms of a systemic necrosis, but the recovery is rarely so complete as with 'guar virus'. The recovered plants set very few seeds.

Attenuated strain of 'guar virus'

A few plants in the field were observed which showed very mild symptoms with faint mottling and stunting but without any necrosis. When the sap from these plants was inoculated on guar, faint mottling appeared but no other symptoms were produced. On tobacco (*Nicotiana tabacum* L. var. White Burley), mosaic mottling was observed which soon disappeared.

To confirm the presence of an attenuated strain-cross protection experiments were carried out. The plants were first inoculated with the virus from infected plants showing mild symptoms and then after a period of few days the parent strain was inoculated in the same plants. Ten guar plants were used in each experiment and the results showed that if a healthy guar plant was inoculated with the attenuated strain and then after a fortnight with the virulent strain there appeared no symptoms of the lethal disease in the inoculated plant. Therefore, the attenuated strain conferred resistance against virulent strain by its presence. If the virulent strain was inoculated within a fortnight of the infection by attenuated strain the plant showed symptoms of the necrotic disease. It was concluded,

therefore, that the attenuated strain become fully systemic in a fortnight inside the host plant and thus resists the multiplication of the virulent strain.

DISCUSSION

Zaumeyer and Harter (1943) described bean mosaic virus 4 and 4A which produced local lesions on some bean varieties and systemic infection in others. Their virus had thermal death point of 90°C and 95°C, dilution end point of more than 10^{-5} and longevity *in vitro* at 18°C of 32 weeks. Later Chester and Cooper (1944) reported "Lethal virus of guar" from Oklahoma which differed from bean virus 4 and 4A in that it infected cowpea, soybean, mungbean and petunia. The physical properties of lethal virus of guar have not been described. The virus causing top necrosis of guar described here also produced local and systemic infection on some bean varieties, infected cowpea, soybean, mungbean and petunia but it will be difficult to relate the virus with bean virus 4 and 4A or lethal virus of guar as long as its physical properties are unknown. Le Beau (1947) has also described a virus causing top necrosis in beans and having thermal death point of 68°C. He thought this virus to be related with lethal virus of guar described by Chester and Cooper but the virus investigated here is different from Le Beau's virus also, in symptom expression on bean varieties and in not infecting *Pisum sativum* and *P. arvens* although the thermal death point is very much similar. Cooper (1949) later on described a sap transmissible virus causing top necrosis of guar, of which thermal inactivation point was approximately 60°C, dilution end point 10^{-3} and longevity *in vitro* 2 months at 5°C. He has referred it as a new distinct variety of tobacco ringspot virus. The virus reported here resembles in many respects with Cooper's distinct variety of tobacco ring spot virus but still slightly differs in host range, host reaction, disease symptom expression, in being followed by an attenuated strain in nature and in some of the physical properties. It is, therefore, suggested that the virus described here may be regarded as a strain of tobacco ring spot virus. As far as authors are aware this is the first record of this disease from tropical countries.

SUMMARY

"Top necrosis" a virus disease of guar (*Cyamopsis tetragonoloba* (L.) Taub) has been described. The symptoms included light chlorotic mottling, yellowing and bronzing of leaves giving almost burnt appearance to the upper part of the plant. Leaflets developed small chlorotic depressions which later became necrotic. Histopathologically the necrosis started superficially and later spread into the mesophyll. The vascular tissues remained apparently normal.

The virus was mechanically transmissible to a few varieties of bean, cowpea, petunia, datura, nightshade and white burley tobacco. The virus has dilution end point of 1 : 1000, thermal death point of 70°C and longevity *in vitro* of 6 days. An attenuated strain is usually accompanied which protects the plants from being infected by the virulent strain. The present virus differs from known viruses attacking guar but resembles in some respects with a distinct variety of tobacco ring spot virus of which it might be a strain.

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A NEW SPECIES OF *PALORUS* MULSANT (TENEBRIONIDAE: COLEOPTERA) ON CASTOR

By

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Chatterji *et al.* (1960) and Sarup *et al.* (1960) described some new species of *Derispia* Lewis and *Palorus* Mulsant respectively. In this paper, the description of another new species of *Palorus* Muls. on *Ricinus communis* is given.

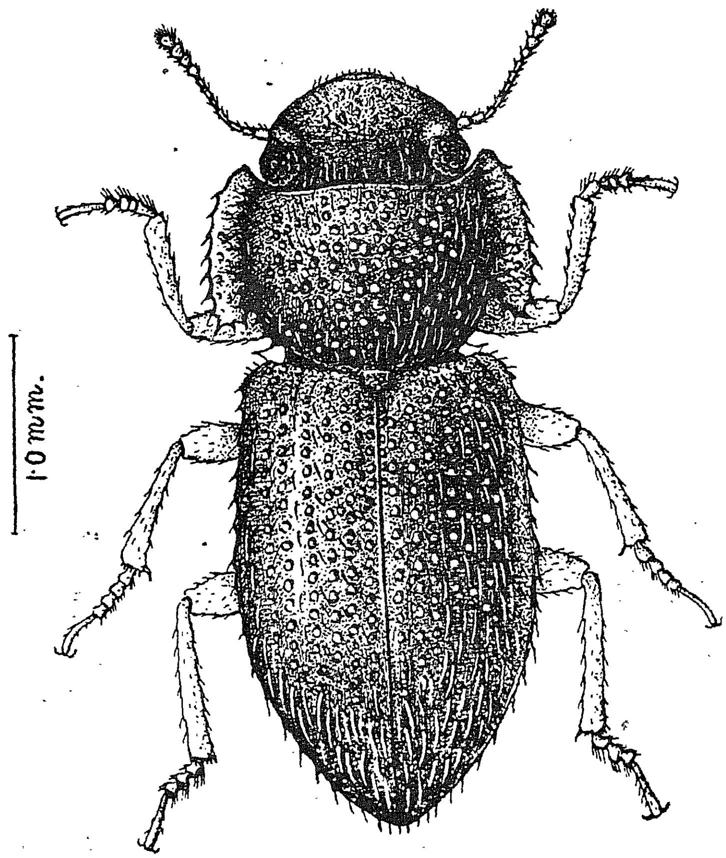
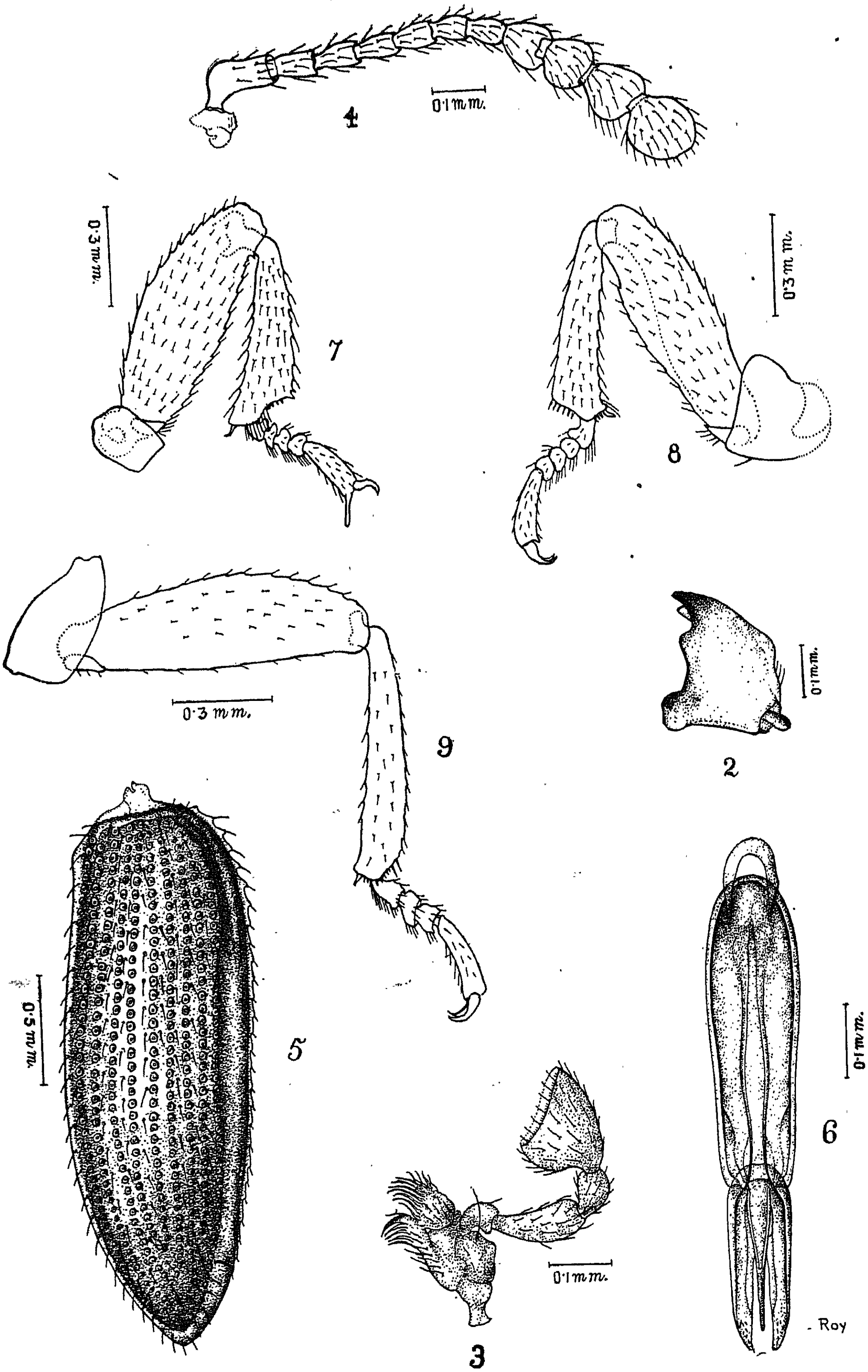


Fig. 1. *Palorus sinui*, sp. nov.



Palorus sinui, sp. nov.

Fig. 2. Mandible. 3. Maxilla. 4. Antenna. 5. Elytron. 6. Male genitalia. 7. Fore leg. 8. Middle leg. 9. Hind leg.

concealed by supra-antennal orbits ; frons slightly convex, densely punctate, hairy; clypeus closely punctate, hairy, anterior margin slightly concave ; antennary orbits raised, covering nearly half the scape ; under side of the head closely and coarsely punctate ; labrum flat, lateral margins slightly serrated, angles rounded, anterior margin slightly concave, fringed with hairs ; mandible (Fig. 2) bidentate, upper tooth more pointed than the lower ; maxillary pa pus (Fig. 3) hairy, four segmented, terminal join flat and much wider at the apex. Antenna (Fig. 4) testaceous, hairy, eleven segmented, scape longer than all the segments, II, IV, V, and VII segments sub-equal, slightly less than half the length of the first, third slightly bigger than the second, sixth slightly smaller than fifth, eighth and ninth sub-equal, about half the scape, tenth bigger than the ninth, terminal segment slightly less than three-fourths the scape.

Pronotum transverse, explanate laterally, anterior margin weakly sinuate, lateral margins strongly wavy, each crest with hairs, anterior and posterior angles prominent, basal margin strongly sinuate ; disc strongly convex, densely and strongly pitted, more coarsely so towards the sides, hairy. Scutellum transverse, with about six large punctures, each with a seta.

Each elytron (Fig. 5) three times as long as its width at the anterior end, widest almost in the middle, anterior outer side feebly rounded, posteriorly somewhat tapering ; outer margin serrated, slightly inflexed ; striae strongly and closely pitted, first stria runs only upto one sixth the length of elytron, second and tenth, third and eighth, fourth and seventh, fifth and sixth contiguous at the tapering end, ninth stria incomplete, not reaching the tapering end ; intervals with stiff hairs.

Prosternum slightly narrower posteriorly, between the anterior coxae raised, inter-coxal bridge only about one-seventh of the width of the prosternum, anterior border of coxal cavities half way up the length of the sternum, finely pitted, hairy. Anterior coxa slightly diagonal. Mesosternum depressed in the middle, narrower at the sides and also in between the middle coxae, feebly keeled in the middle, the keel running anterio-posteriorly and ending abruptly in the centre, finely pitted, hairy. Middle coxae more or less parallel to the fore coxae. Metasternum transverse, slightly convex, between the borders of middle and hind coxal cavities slightly shorter than the transverse length of the hind coxa, strongly pitted, hairy.

Abdominal sternites densely pitted, hairy ; fourth visible sternum smallest, narrower, with the posterior margin slightly concave. Pygidium concealed beneath the elytra. The phallic complex (Fig. 6) comprises a massive structure with lateral lobes and a median slightly more sclerotized, narrow, wavy pointed structure. It more or less resembles with *Palorus shikhae* Sarup Chatterji and Menon but differs from the latter in being much narrower, in that the median lobe is more pointed and not heavily sclerotized, and in differentiation of lateral lobes.

Legs dark reddish-yellow. Fore leg (Fig. 7) : coxa sub-globose, torchanter short, tapering, with hairs ; femur stout, slightly curved, broadest about the middle, margins serrated, about two and a half times its maximum width, with hairs ; tibia slightly less than five times its maximum width, margins serrated, apex denticulate and about two times as wide as the base, fringed with short hairs ; tarsus five segmented, first joint about two times the second, second and third subequal, much wider than long, fourth smaller than the first, fifth more or less cylindrical, a little more than first four segments put together ; tarsus pilose ; claws simple. Middle leg (Fig. 8) : coxa almost broadly ob-conical ; trochanter short, tapering, sparsely

bristly ; femur broadest about the middle, less than three times its maximum width, margins serrated, hairy ; tibia more than five times its maximum width, apex wider than base, denticulate, margins serrated, with short hairs ; tarsus five segmented, first joint about one-third the claw bearing joint, second and third sub-equal, fourth smallest, fifth a little more than the first four segments put together ; tarsus pilose beneath ; claws simple. Hind leg (Fig. 9) : coxa distinctly transverse, its width nearly two times its maximum length ; trochanter short, anterior margin transversely truncate, sparsely bristly ; femur broadest at the middle, more than three times its maximum width, margins serrated, apex rounded ; tibia more than six times its maximum width, broadest at the distal end, apex denticulate, margins serrated ; tarsus four segmented, first joint about one-third the claw bearing joint, second smaller than the first, third smallest, fourth more than the first three joints put together ; tarsus pilose beneath ; claws simple.

Holotype :

Male specimen dissected on different slides, labelled "on *Ricinus communis* from Trivandrum, South India" S. M. Chatterji coll. 1958. Deposited in the National Pusa Collection, Division of Entomology, Indian Agricultural Research Institute, New Delhi–12.

Blair (1930) has given a key for Indian species of *Palorus*, but this species does not fit in it. However, this species is allied to *Palorus shikhae* described by Sarup, Chatterji and Menon, but it differs markedly from the latter in (*i*) absence of concentric arcs of scutellar punctures, (*ii*) in having wavy margin of prothorax, with hairs (*iii*) in having elytral intervals with stiff hairs, (*iv*) in having serrated margins of legs and (*v*) in the structure of the phallic complex.

ACKNOWLEDGMENT

The author is indebted to Dr. E. S. Narayanan, Head of the Division of Entomology, for his keen interest in the work and to Dr. M. G. Ramdas Menon, Systematic Entomologist, for his constant encouragement during the determination of this species. Grateful thanks are due to Dr. Snehamoy Chatterji for kindly giving his tenebrionid collection for study and for going through the manuscript. Thanks are also due to Shri A. K. Roy Artist, for making the sketches.

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PAPER CHROMATOGRAPHY OF GALLS OF *URTICA DIOICA* L. CAUSED BY *PUCCINIA CARISIS* (SCHUM.) REBENT

By

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INTRODUCTION

Several workers have observed the formation of new compounds, disappearance of several existing ones or changes in concentration of many constituents of plant tissues when they get infected with various fungi. Andal and Subba Rao (1956) observed that although proline was present in the healthy tissues, it disappeared from the portions of rice plant infected with *Fusarium moniliforme.* They also found that the chlorotic leaves of the infected plants had three other amino acids, *viz.* serine, glycine and phenyl alanine, in place of glutamic acid, proline and methionine. Gupta and Gupta (1962) have observed that fructose, sucrose and raffinose disappeared from the seeds of infected plants of *Coriandrum sativum* with *Protomyces macrosporus.* Formation of indole acetic acid by several fungi which cause hyperthrophy or hyperplasia in the host plants has been reported by several workers (Grady and Wolf, 1959).

Aecidial stage of *Puccinia carisis*, which causes gall formation on the leaves, petiole and stem of *Urtica dioica*, is of common occurrence in Naini Tal just after the start of rains in June. The infected parts of the plant get deformed and very much hypertrophied. They become soft and yellowish green in colour. These hypertrophied portions of the plant, which are sweet in taste, are called '*sishun kakri*' and enjoyed by the local people.

The present chromaographic study was undertaken to examine the changes in the non-volatile carboxylic acids, sugars and amino acids in the healthy and infected parts of the host ; and to investigate whether indole–acetic acid is produced by *P. carisis* in the hypertrophied tissues of *U. dioica.*

EXPERIMENTAL

Equal weights of healthy and infected hypertrophied stem portions of host plant were separately macerated with known volumes of 80% ethanol. The extracts from the crushed portions were centrifuged and freed from inorganic salts by treating them in an electrolytic desalting apparatus. Equal volumes of extracts thus obtained from the healthy and diseased tissues of the host plant were separately spotted on Whatman filter paper No. 1 for the characterization of non-volatile carboxylic acids, amino acids and sugars. For indole–acetic acid ether extracts were used as mentioned by Wolf (1956). Solutions (0·1%) of reference compounds were also spotted simultaneously along with the test liquids.

(*a*) *Non-volatile carboxylic acids.*—Descending chromatographic technique was employed for the characterization of non-volatile carboxylic acids. Butanol–formic acid–water (4: 1 : 5, v/v) was used as developing solvent mixture. After developing for 48 hours, the chromatograms were air dried over night, heated in an electric oven for 4–8 hours at 80°C and were finally sprayed with bromo–phenol blue

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(0·04 gm. in 100 ml. of 95% ethanol). The carboxylic acids were detected as lemon yellow spots.

Malic (R*f*=0·52) and an unidentified acid with 0·25 R*f* value (probably quinic acid) were detected both in the healthy and the diseased portions of the host. The unidentified acid was, however, found to be at a higher concentration in the healthy portions as indicated by the larger area and the greater intensity of the colour of the spots.

(*b*) *Sugars.*— Sugars were identified by descending method of chromatography using Butanol–acetic acid–water (4 : 1 : 5, v/v) as a developing solvent and benzidine reagent (0·5 gm. benzidine, 10 ml. of 45% trichloroacetic acid and 100 ml. of ethanol) as a spray reagent for locating the spots of various sugars.

Only glucose, fructose and sucrose (R*f*=0·17, 0·21 and 0·10 respectively) were identified both in the extracts of healthy and diseased portions. The spots were, however, bigger and intenser in colour in the case of the extract of diseased portion thus indicating greater concentration of sugars in them in comparison to the healthy ones.

(*c*) *Amino acids.*—The chromatograms were developed with Butanol–acetic acid–water (4 : 1 : 5, v/v) solvent by the descending technique for 30 hours, air dried for 18 hours, sprayed with 0·1% solution of ninhydrin in acetone (Giri and Rao, 1952) and finally heated in an electric oven at 65°C for 10 to 15 minutes. Various amino acids were usually located as pink spots.

Asparagine, aspartic acid, serine, tyrosine and tryptophane (R*f*= 0·14, 0·19, 0·38, 0·56 and 0·63 respectively) were detected in both healthy and hypertrophied portions of the host. Like sugars, the intensity and area of the spots of amino acids were greater in the case of the extract from the diseased portions thus indicating greater concentration of amino acids in them.

(*d*) *Indole–acetic acid.*—The chromatograms were developed by ascending technique with isopropanol–ammonia–water (10 : 1 : 1, v/v ; Wolf, 1956), air dried and sprayed with potassium nitrate-nitric acid reagent (1·0 gm. potassium nitrate, 20 ml. concentrated nitric acid and 80 ml. 95% ethanol ; Wolf, 1956). Indole–acetic acid gave a red spot by this reagent.

No indole–acetic acid was detected in the extracts of the healthy or hypertrophied tissues of the host in these investigations. It is, however, interesting to record here that tryptophane (R*f*= 1·63), which was regarded by Crady and Wolf (1959) as the starting amino acid for the synthesis of indole–acetic acid by *Taphrina deformans* and *Dibotryon morbosum*, was found to be present in both healthy and diseased portions.

SUMMARY AND CONCLUSIONS

Using various chromatographic techniques, malic and an unidentified non-volatile carboxylic acid with 0·25 R*f* value, glucose, fructose, sucrose, asparagine, aspartic acid, serine, tyrosine, and tryptophane were found to be present in both the healthy stem and the galls formed on *Urtica dioica* by the infection of *Puccinia carasis*. The concentration of amino acids and sugars was considered to be greater in the diseased portions. Indole–acetic acid was not detected in the hypertrophied tissues of the host.

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STUDIES ON THE NUTRITION OF *CURVULARIA PENNISETI* (MITRA) BOED. II. INFLUENCE OF DIFFERENT COMBINATIONS OF VARIOUS SOURCES OF CARBON AND NITROGEN

By

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It has been shown earlier (Tandon and Chandra, 1962) that the carbon as well as nitrogen sources in the medium showed marked influence on the growth and sporulation of *Curvularia penniseti.* Very few workers have studied the influence of one carbon source on the utilization of different sources of nitrogen or vice-versa. Timnick *et al.* (1951) reported that lactose and starch were always poor carbon sources for the growth of *Melanconium fuligineum* irrespective of the nitrogen sources used in combination with them. Tandon and Bilgrami (1957) working on *Pestalotia mangiferae* observed slight improvement in the growth on rhamnose, lactose or glycerol when they were used in combination with dl–valine or glutamic acid as compared to their combination with potassium nitrate. Results reported in this paper relate to the influence of different combinations of various sources of carbon and nitrogen on the growth and sporulation of *C. penniseti.*

MATERIAL AND METHODS

Glucose and potassium nitrate of the basal medium* were replaced by various other carbon and nitrogen sources. The amounts of carbon and nitrogen of the substances tested were so adjusted as to conform to the quantities present in the basal medium. The dry weight was recorded after 15 days growth ; the sporulation was noted after 5, 10, 15 days incubation. The sporulation has been indicated on the basis of the number of spores present in the low power field of the microscope *viz.*, Nil– Absent, 1–10 : Poor, 11–20 : Fair, 20–30 : Good, Above 30 : Excellent. Methods of cultivation and harvest were same as described previously (Tandon and Chandra, 1962). The following compounds were included in the present study :

Carbon sources :

Galactose, glucose, lactose, fructose, rhamnose, malic acid and mannitol.

Nitrogen sources :

Asparagine, urea, potassium nitrate, Dl–valine, glycine, aspartic acid and sodium nitrite.

EXPERIMENTAL

The dry weight of the fungal mats and rate of sporulation on different combinations are recorded in Tables 1 and 2 respectively. There was no growth on any combination of mannitol or sodium nitrite and hence they have not been included in Table 2.

*Glucose 5·0 g, KNO_3 3·5 g, KH_2PO_4 1·75 g, $MgSO_4 . 7H_2O$ 0·75 g, Distilled water 1 litre.

TABLE 1

Showing dry weight (in mg) of *Curvularia penniseti* on combinations of various carbon and nitrogen sources.

Nitrogen sources	Dry weight in mg Carbon sources						
	Galactose A	Glucose B	Lactose C	Fructose D	Rhamnose E	Malic acid F	Mannitol G
1. Asparagine	106·2	102·2	96·2	90·2	48·2	24·1	0·0
2. Urea	94·9	93·2	87·1	82·0	34·1	24·7	0·0
3. Potassium nitrate	85·1	84·7	81·1	78·3	27·1	22·3	0·0
4. Dl–valine	99·5	94·2	88·2	84·3	42·1	25·1	0·0
5. Glycine	43·4	42·2	38·0	35·2	22·2	18·0	0·0
6. Aspartic acid	26·2	24·2	21·3	23·1	20·0	13·2	0.0
7. Sodium nitrite	0·0	0·0	0·0	0·0	0·0	0·0	0·0

Average = 41·2

Summary of dry weight results and conclusions at 5% level of P.

Treatments	. .	Highly significant	S.E. = 1·647
Replicates	. .	Non-significant	C.D. at 5% level = 4·83

Dry weight results :

1A 1B 4A 1C 2A 4B 2B 1D 4C 2C 3A 3B 4D 2D 3C 3D > 1E 5A 5B

4E 5C 5D 2E > 3E 6A 4F 2F 6B 1F 6D 3F 5E 6C 6E 5F 6F

TABLE 2

Showing rate of sporulation* of *Curvularia penniseti* on combinations of various carbon and nitrogen sources.

Nitrogen sources	No. of days	Carbon sources: Galactose	Glucose	Lactose	Fructose	Rhamnose	Malic acid
Asparagine	5	+	++	+	++	—	—
	10	++	+++	++	+++	+	—
	15	+++	++++	+++	++++	++	+
Urea	5	+	+	+	++	—	—
	10	+++	++	++	++	+	+
	15	+++	+++	+++	++	+	+
Potassium nitrate	5	+	++	+	++	—	—
	10	++	++	++	++	+	—
	15	++	+++	+++	+++	+	+
Dl–valine	5	+	+	+	+	—	—
	10	++	++	+	++	—	—
	15	++	++	++	+++	+	+
Glycine	5	—	+	—	+	—	—
	10	+	++	+	+	+	+
	15	++	++	++	++	+	+
Aspartic acid	5	—	+	—	—	—	—
	10	+	+	+	+	+	—
	15	+	+	+	+	+	—

* — : No sporulation
\+ : Poor ,,
++ : Fair ,,
+++ : Good ,,
++++ : Excellent ,,

It is clear from Table 1 that all the combinations of galactose, glucose, lactose and fructose with asparagine, urea, potassium nitrate or dl–valine proved to be good for the growth of *Curvularia penniseti*. The growth was always poor on malic acid irrespective of the nitrogen sources used. Aspartic acid in combination with any of the carbon sources supported only poor growth.

Table 2 reveals that only combinations of asparagine with glucose and fructose could support excellent sporulation. A critical study of both the tables indicates that there was close correlation between the growth and sporulation on nearly all the combinations used. Good growth was always associated with good sporulation. The combination of malic acid with any nitrogen source (except aspartic acid) supported poor growth as well as poor sporulation. Similarly aspartic acid always proved to be a poor source for the sporulation irrespective of the carbon source used in its combination (except malic acid, where there was no sporulation). It also shows that the rate of sporulation remained stationary on aspartic acid-glucose combination while on other combinations it changed after 5th day (*e.g.*, fructose—Dl–valine) or 10th day (*e.g.*, lactose—Dl–valine).

DISCUSSION

In nature pathogenic fungi come in contact with combinations of a variety of carbon and nitrogen compounds, thus nutritional studies will be incomplete if possible interactions between carbon and nitrogen sources are not considered. In the present investigation mixture of good carbon and good nitrogen sources (on the basis of previous results ; Agarwal, 1955 ; Tandon and Chandra, 1962) proved to be good combinations for the growth and sporulation. When poor carbon sources such as malic acid, rhamnose, were combined with good nitrogen sources, (*e.g.*, asparagine and urea) very little or no improvement in the growth or sporulation was recorded. Similar results were obtained by Bilgrami (1956) for *Phyllosticta cycadina* and *P. artocarpina*. Timnick *et al.* (1951) working on *Melanconium fuligineum* reported that poor quality of lactose and starch could not be improved by the use of efficient nitrogen sources. The sporulation on some of the combinations appeared earlier and reached the maximum soon while on others it was delayed. The results clearly reveal that the rate of sporulation has no relation with the type of carbon and nitrogen source in the medium. It was interesting to note that there was a close correlation between the amount of mycelial growth and degree of sporulation. The present results differed from those of Tandon and Bilgrami (1957) who observed that there was no correlation between growth and sporulation of *Pestalotia mangiferae* on various combinations of different carbon and nitrogen sources. An interesting feature of the present work was that except for few instances, the order of efficiency of various carbon sources remained the same irrespective of the nature of the nitrogen source in the medium. The reverse was also true in most of the cases. Natarajan (1958) working on a number of Fusaria also reported that the nitrogen source in the medium could not change the order of efficiency of the carbon sources.

SUMMARY

The effect of different combinations of carbon and nitrogen sources on the growth and rate of sporulation was studied. All the combinations of galactose, glucose, lactose and fructose with asparagine, urea, potassium nitrate or Dl–valine proved to be good combinations for the growth. There was a close correlation between growth and sporulation on various combinations. The rate of sporulation varied with the combinations but it was not dependent on the type of carbon or nitrogen source used.

ACKNOWLEDGEMENT

The authors are grateful to Dr. K. S. Bilgrami for his help and suggestions. The junior author is indebted to the Ministry of Scientific Research and Cultural Affairs for the award of Research Training Scholarship.

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A CONTRIBUTION TO THE EMBRYOLOGY OF *MYRTUS COMMUNIS* L.

By

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A summary of the earlier work on Myrtaceae has been given by the writer in a previous communication while dealing with the life history of *Psidium guajava* (Narayanaswami and Roy, 1960). *Myrtus communis* has been previously worked out by Greco (1930) who reported a Normal type of embryo sac development in it. With a view to exploring the possibility of polyembryony, a feature common in several species of the geuns *Syzygium* (Narayanaswami and Roy, 1960), in *Myrtus communis*, a study of the embryology along with a detailed account of the structure and development of the ovule has been taken up in the present paper.

MATERIAL AND METHOD

The material used for the investigation was collected from plants growing in the Horticultural gardens, Saharanpur. Fixation was done in formalin-acetic-alcohol on the spot after trimming off the ovary wall from the sides. Customary methods of dehydration and infiltration were followed and sections of the ovaries were cut at 10–15 μ thick, and stained in Haidenhain's iron-haematoxylin and safranin-fast green.

OBSERVATIONS

Megasporogenesis, female gametophyte and the ovule :

The megaspore mother cell which is deeply seated in the nucellus forms a linear tetrad of megaspores ; although sometimes, a triad may be formed, the upper dyad cell being arrested in its division (Fig. 1). The chalazal megaspore is functional, and its nucleus by three successive divisions gives rise to a Normal type of embryo sac which is curved from an early stage (Fig. 2.).

In the organized embryo sac the egg cell shows the normal pyriform structure. It is less conspicuous than the synergids and is partly overlapped by the latter (Fig. 3). The synergids are nearly of the same length as that of the egg. Usually they show a large apical vacuole, the nucleus being situated at the basal end. Sometimes the basal ends of mature synergids are highly vacuolated and take the place of filiform apparatus. In one of the synergids a prominent recurved hook was observed (Fig. 4). Figure 5 shows a synergid which is swollen and full of vacuolated cytoplasm, the nucleus being situated at the apical end similar to that of an egg. The antipodal cells disorganize at an early stage being pushed to chalazal extremity of the embryo sac where they ultimately degenerate (Fig. 6). They are always absent from the mature embryo sac. The polar nuclei remain closely appressed to each other until the egg cell is fertilized.

The mature ovule is anatropous and bitegminal. But soon after fertilization the ovule along with the embryo sac curves to become campylotropous (Fig. 7). The inner integument is uniformly two cells thick and presents a degenerating appearance from an early stage except at the micropylar region where it is slightly

swollen. The inner layer bordering the nucellus is affected first and is flattened out due to compression. It takes on a dense stain characteristic of degenerating cells and can be observed at various stages of development of the seed.

The outer integument is also two cells thick but occasionally may be thicker. The tip of the outer integument is swollen composed of three to four cell-layers.

The micropyle is either straight or zig-zag in its course (Figs. 7, 8). Normally both the integuments take part in the formation of the micropyle.

The nucellus is massive and at the time of fertilization is five to eight cells thick all around except at the chalazal end where about fifteen layers of cells are present, from which a group of cells below the embryo sac becomes thick-walled and constitutes the hypostase (Figs. 7, 9). The growth of the embryo sac towards the chalazal direction is checked by the hypostase for some time but the embryo sac expands sideways.

Fertilization :

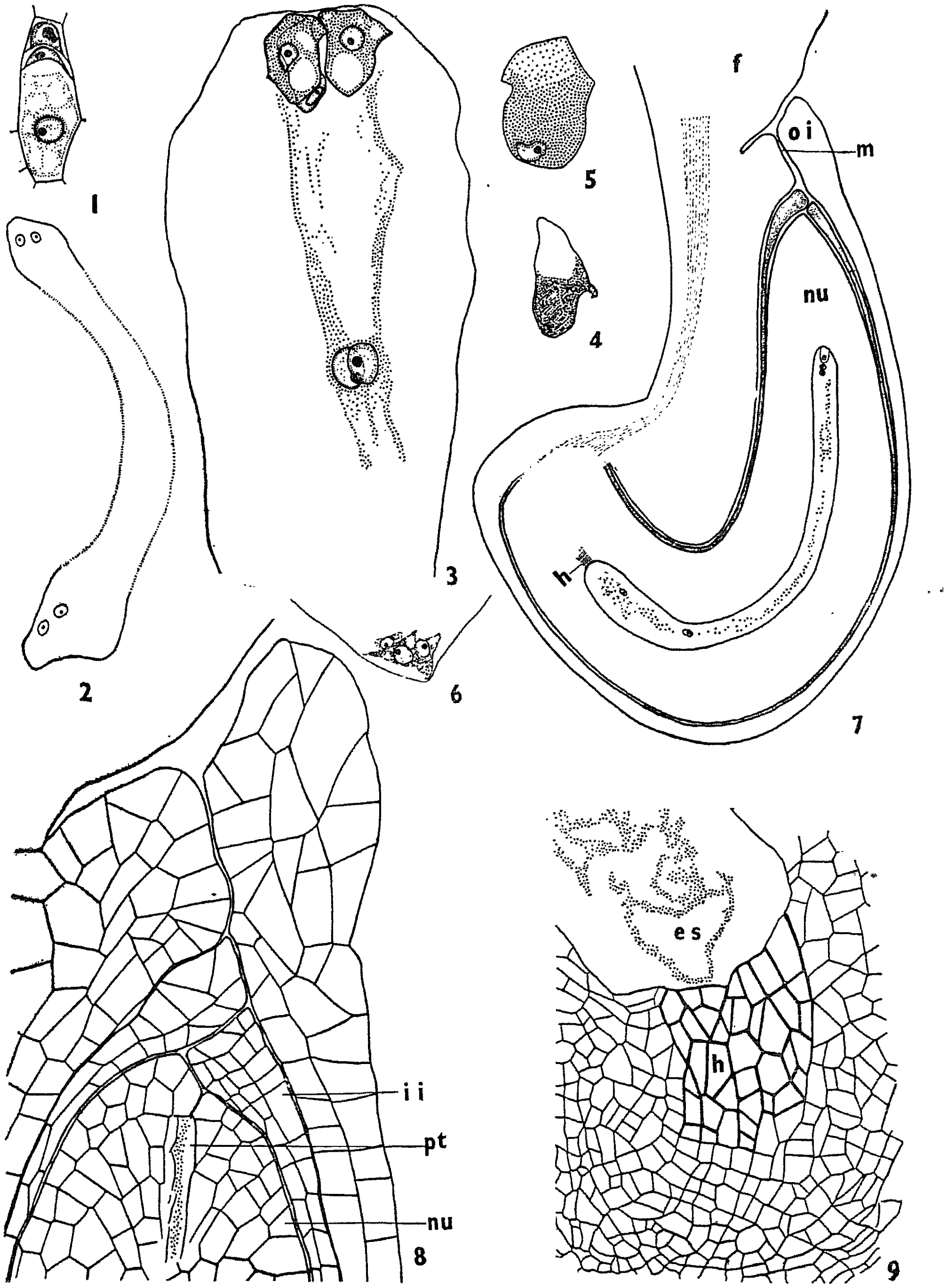
Fertilization is porogamous. The pollen tube traverses the zig-zag course of the micropylar canal and passes between the cells of the nucellus overlying the embryo sac (Fig. 8). At fertilization, one of the synergids degenerates first (Fig. 10). Presence of two nucleoli within the egg nucleus perhaps represented syngamy, one of these representing a sperm. The second sperm fuses with one of the polar nuclei (Fig. 11) prior to the formation of the secondary nucleus. The fertilized polar nucleus is differentiated from the unfertilized one by its bigger size and more conspicuous nucleolus (Fig. 10). Ultimately the fertilized and unfertilized polars fuse between themselves and complete the process of triple fusion. The second synergid also degenerates at this stage and the zygote undergoes a prolonged period of rest (Fig. 12).

Endosperm :

The primary endosperm nucleus divides promptly and repeatedly resulting in the formation of a large number of free nuclei, many of which accumulate at the chalazal end (Fig. 12), the rest being distributed more or less uniformly at the periphery of the embryo sac. Division of the endosperm nuclei at the chalazal end is rapid, and by the time the young embryo is formed a pronounced chalazal accumulation of endosperm nuclei is noticed. The nuclei remain embedded in dense cytoplasm and undergo random fusion among themselves. The endosperm remains nuclear for a considerable period and ultimately is transformed into a cellular mass.

Embryo :

The first division of the zygote is transverse (Fig. 13), the basal cell being the larger one. The second division occurs in the basal cell and is transverse (Fig. 14) ; the third and a few following divisions take place transversely in the derivatives of the basal cell so that the proembryo is represented by a filamentous row of several cells (Figs. 15, 16). The terminal cell divides vertically (Figs. 16, 17) and then transversely to form the quadrant (Fig. 18). Each cell of the quadrant divides vertically to form the octant (Fig. 19). The cell above the quadrant or octant undergoes longitudinal divisions so that a horizontal row of four cells is formed (Fig. 20). This row takes part in the formation of the embryo proper. Any cell in the row forming the suspensor may divide vertically or obliquely vertically (Figs. 16, 18, 20). Each seed contains only one embryo which is clearly zygotic and no case of polyembryony could ever be observed.



Figs. 1–9. (Abbreviations used : *es*, embryo sac ; *f*, funiculus ; *h*, hypostase ; *ii*, inner integument ; *oi*, outer integument : *m*, micropyle ; *nu*, nucellus ; *pt*, pollen tube).
Fig. 1. Triad. × 465.
Fig. 2. 4–nucleate embryo sac. × 202.
Fig. 3. Upper part of embryo sac, showing egg apparatus and polars, the lower part showed no antipodals. × 465.
Fig. 4. Hooked synergid. × 465.
Fig. 5. Vesicular synergid. × 465.
Fig. 6. Lower part of embryo sac showing antipodals. × 465.
Fig. 7. L.s. ovule, showing different parts. × 120.
Fig. 8. Upper part of ovule of Fig. 7 magnified to show zig-zag course of micropyle. × 279.
Fig. 9. Chalazal part of an ovule showing structure of hypostase. × 279.

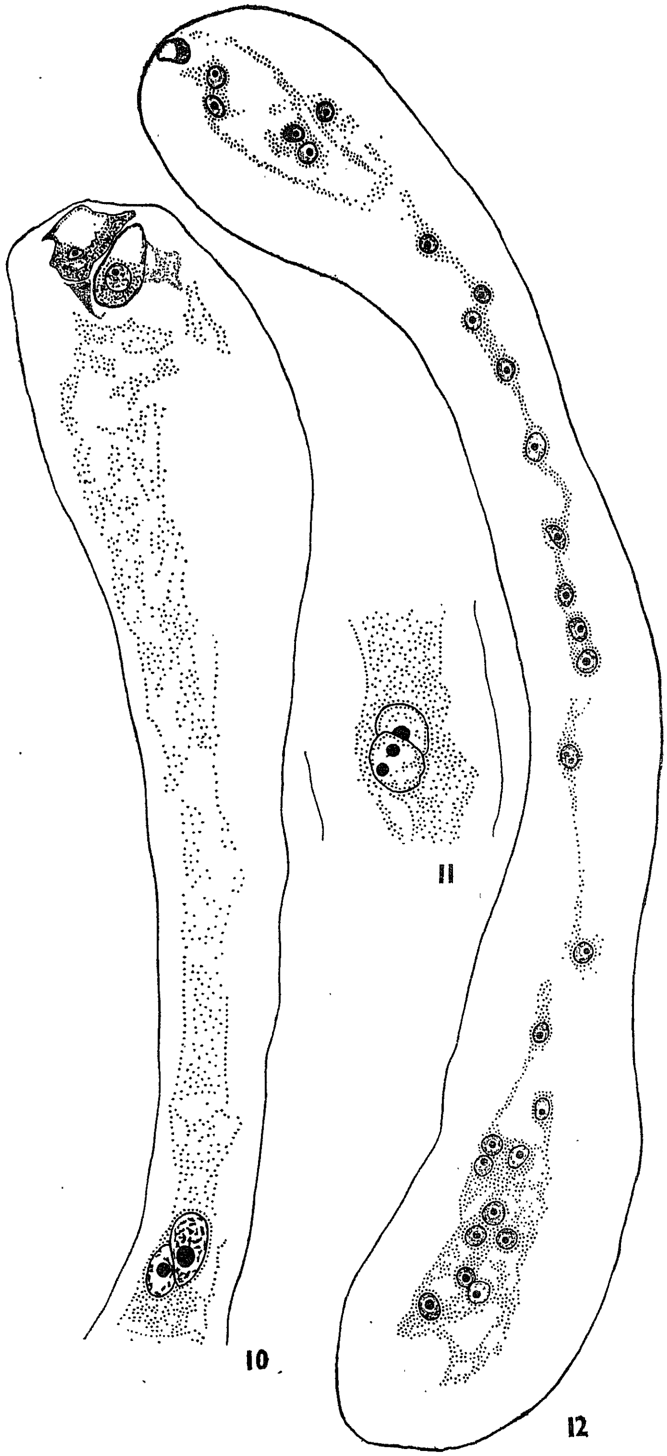
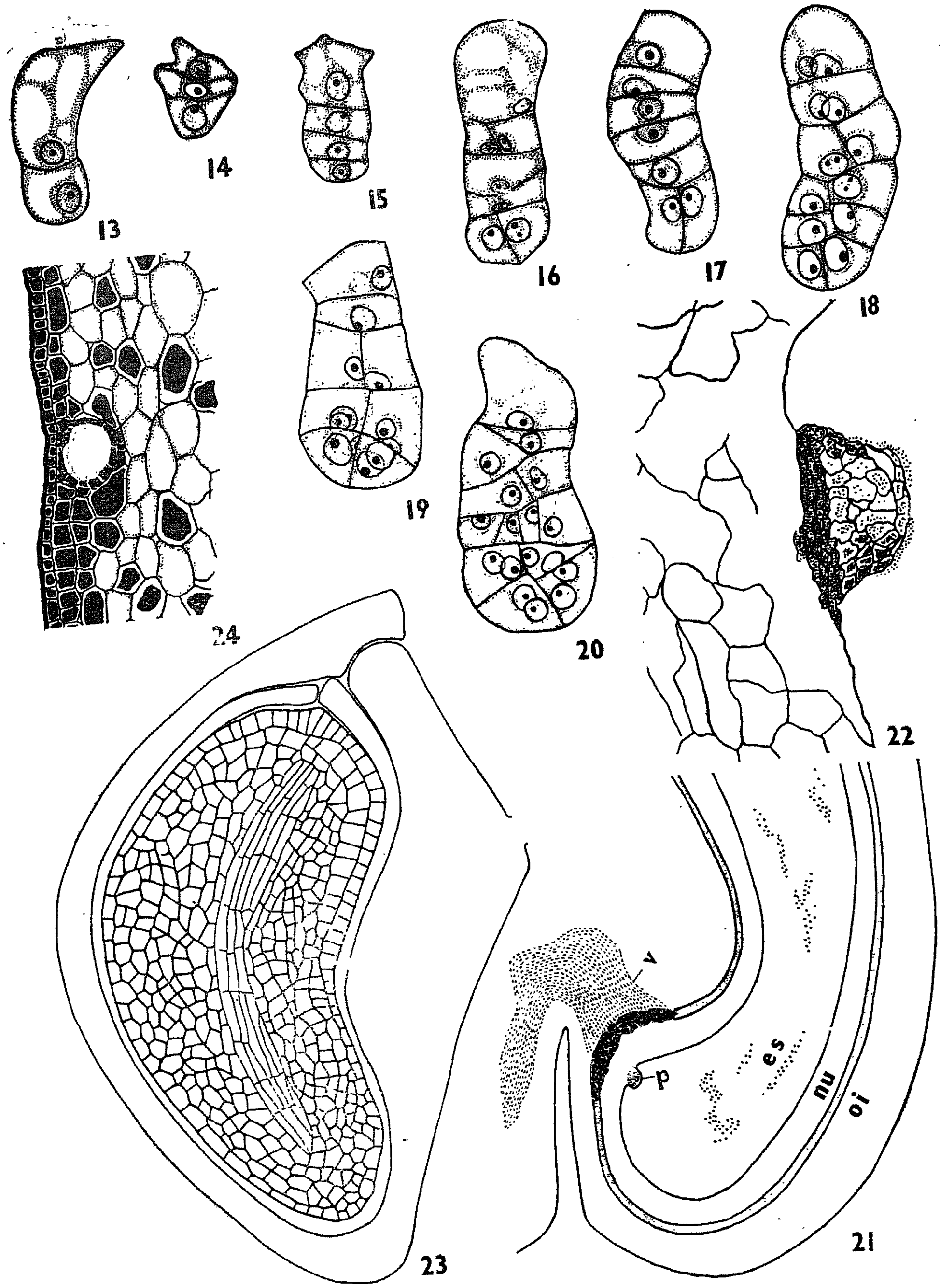


Fig. 10. Upper part of embryo sac showing zygote, degenerating synergid, one fertilized and another unfertilized polar nucleus. × 465.
Fig. 11. Two polar nuclei from the middle of an embryo sac ; the lower polar nucleus showing two nucleoli, one of these representing a sperm. × 465.
Fig. 12. Embryo sac showing zygote and free endosperm nuclei. × 465.



Figs. 13–23. (Abbreviations used : *es*, embryo sac ; *nu*, nucellus ; *oi*, outer integument ; *p*, postament ; *v*, vascular supply).

Figs. 13–20. Stages in development of embryo. × 465.
Fig. 21. Chalazal part of young seed to show postament. × 47.
Fig. 22. Postament of Fig. 21 enlarged. × 279.
Fig. 23. L.S. sterile ovule. 202.
Fig. 24. Part of pericarp. × 279.

By the time the embryo becomes multicellular, the ovule curves to become more or less campylotropous and due to the exertion of continuous pressure by the growing embryo sac on the hypostase, the latter is rendered into a crumpled mass of degenerating cells, the 'Postament' (Mauritzon, 1934), which projects into the embryo sac (Figs. 21, *p*. 22).

Occurrence of sterile nucelli which never developed an embryo sac in them was a characteristic feature in many ovules (Fig. 23). These ovules grow normally along with the fertile ones but degenerate after pollination.

Testa and Pericarp :

The testa is formed by the cells of the outer integument, the inner being obliterated completely. The outer integument becomes many layered and lignified resulting in the formation of a hard seed coat.

The raw fruit wall is leathery and consists of several layers of parenchymatous cells of which many are filled with densely staining material. Below the epidermis lysigenous oil cavities are present. The cavities are lined with glandular epithelium (Fig. 24), the cells of which secrete a sweet smelling volatile oil characteristic of the plants of the family Myrtaceae.

DISCUSSION

Souèges (1940) studied the embryonomy of *Myrtus communis* and concluded that the development of the embryo is essentially similar to that of Ranunculaceae. Johansen (1950) writes, "Assignment of this species is perhaps best made to the Myosurus Variation, Onagrad Type, since the later divisions in the developing embryo are equally as irregular as in *Myosurus*." In *Myosurus minimus* a tetrad of four cells of the Onagrad type is formed in the proembryo with two juxtaposed cells derived from the terminal cell and the two superposed lower cells derived from the basal cell of the two-celled proembryo. In the present study an Onagrad type of tetrad was not met with, while the proembryo was found to present a filamentous appearance by the formation of a row of cells. Such a proembryo often becomes quite long, composed of six or more superposed cells, contributed by both the cells of the bi-celled embryo. The terminal cell of the long proembryo divides vertically first then transversely to form the quadrant, unlike the second wall lying vertically perpendicular to the first wall in the formation of the quadrant of *Myosurus minimus*. The octant is formed by the division of the quadrant cells vertically perpendicular to the first longitudinal wall. The hypophysis cell, *i.e.*, the cell next to the octant divides vertically and then each of the resultant cells again divide likewise, vertically, so that a horizontal row of four cells is formed. Such a division of the hypophysis is slightly different from that of *Myosurus minimus* (*Cf*. Fig. 36 *D* of Johansen, 1950). The cell lying next to the horizontal row of four cells, now divides vertically and may act as the hypophysis ; while the horizontal row of cells next to the octant might form an integral part of the embryo proper as suggestive from its close fitting with the cells of the octant and the vertically oriented middle-cell walls of the row in contrast with the obliquely oriented walls in the corresponding cells in *Myosurus minimus*. While this presumption still remains to be proved ; one point emerges out from a comparative study of the observations made by Souèges and the present author, and that is, perhaps, the method of cell formation in the proembryo in *Myrtus communis* does not constantly follow the same pattern as given by Johansen (1950). This points to the inconsistency in the stages of embryonomy which, however, is markedly different from what has been described as the extremely irregular method of cell formation in the proembryo of *Psidium* (Narayanaswami and Roy, 1960) or *Eugenia* (Roy, 1955, 1961). It is true that the embryogeny of *Myrtus communis* agrees in the earlier proembryonic stages with that

of *Clematis* as presumed by Johansen (1950). His statement, "the later divisions in the developing embryo are equally as irregular as in *Myosurus*" also appears correct from the scanty preparations of the later stages of the embryo when the seeds become too hard for sectioning.

The embryo in *Myrtus communis* organizes invariably from the zygote and an adventive embryo as found in *Eugenia* (Tiwary, 1926 ; Pijl, 1934 ; Roy, 1961) never develops.

SUMMARY

The anatropous ovule is invested by two integuments, the inner degenerating and the outer persisting. The nucellus is massive and develops a hypostase which gives rise to the 'Postament' due to the expansion of the embryo sac sideways.

Development of the female gametophyte is of the Polygonum type. The antipodals are very elusive, however.

During triple fusion, no secondary nucleus is formed ; one of the sperms fertilizes a polar nucleus which then fuses with the unfertilized one.

The endosperm is Nuclear. A pronounced accumulation of nuclei and cytoplasm at the chalazal end is characteristic.

The proembryo is filamentous. The early proembryonic stages agree to some extent with those of *Clematis* but later stages are irregular. Differences in the stages of embryonomy from Myosure Variatian, Onagrad Type, have been discussed.

A seed develops in it one embryo which is clearly zygotic in origin and no trace of polyembryony could ever be found in this species.

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STUDIES ON GALL MIDGES (ITONIDIDAE : CECIDOMYIIDAE : NEMATOCERA : DIPTERA) FROM INDIA, VI

By

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[Received on 6th March, 1962.]

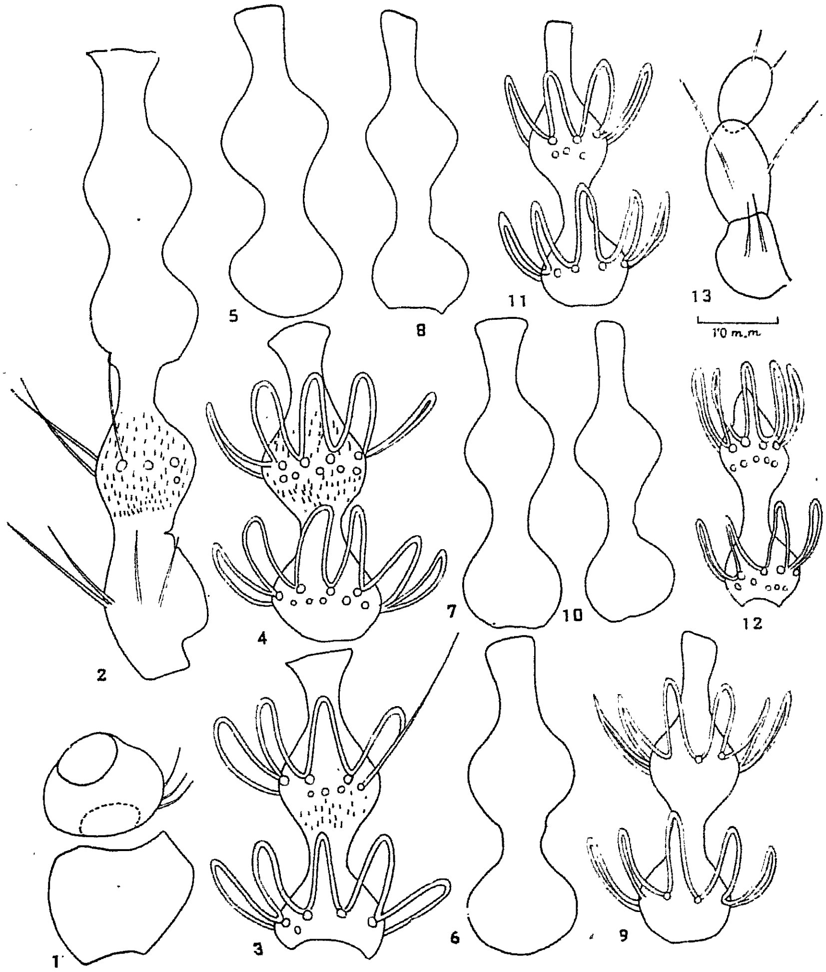
This paper contains description of the sixth species of the genus *Amradiplosis* named by Mani in 1947. Of these four species were described by Rao under the genus *Amraemyia*. Three, namely *Amraemyia amraemyia*, *A. brunneigallicola* and *A. viridigallicola*, were described in 1948 and the fourth *A. keshopurensis* was described in 1952. In 1952 Mani determined Rao's genus *Amraemyia* to be identical with his *Amradiplosis* and discribed the fifth species *A. echinogalliperda*. The present species is the first record from Allahabad, the others were obtained from Kanpur, Keshopur, Bengal and Bihar.

Subfamily *Itonididinae*

Tribe *Bifilini*.

Amraemyia allahabadensis, sp.nov.

Male : *Body* 2·6 mm. long, dark brown. *Eyes* confluent above. *Palpi* (Fig. 13) light brown, sparsely setose ; first segment wider subapically, as long as broad sub-apically and short ; second segment one and two-third times longer than the first and one-and-two-thirds as long as broad, oval ; third segment shorter than the second, slightly longer than the first, length one-and-two-fifths of its own diameter, narrower than the first and second segments, *Antenna* drak brown, nearly twice the length of the body, with 14 binodose segments, enlargements each with one whorl of regular circumfila and one whorl of long setae, apical stems longer than the basal, segments gradually becoming more slender and slightly shorter towards the apex ; scape (Fig. 1) darker than the rest of the antennal segments, short, widest apically, width at the apex nearly one-and-a-half times of its own length ; pedicel (Fig. 1) slightly shorter than the scape, subglobose ; third segment (Fig. 2) fused with and slightly longer than the fourth segment, a little longer than three times the scape, with a short basal prolongation, basal enlargement one-third the length of the segment and a little more than its own thickness, basal stem very short, apical enlargement equal to the basal, apical stem two-thirds the length of the apical enlargement and nearly one-and-two-third times as long as thick, fourth antennal segment (Fig. 2) : basal enlargement wider than long, a little longer than one-third the length of the segment, basal stem one-fourth the length of the basal enlargement and two-and-one-third times as long as thick, apical enlargement longer than the basal, apical stem similar to that of the third segment ; fifth segment (Fig. 3) slightly longer than the fourth a little shorter than the third, basal enlargement a little less than one-fourth the length of the segment and three-fourths as long as thick, basal stem nearly two-fifth the length of the basal enlargement and five-sevenths its own thickness, apical enlargement long and as broad as basal, nearly globose, a little less than one-third the length of the segment, apical stem as long as basal enlargement and twice as long as thick ;



Text-figures 1–13, structure of antennal segments and palpus.

1. Scape and pedicel of ♂
2. Third and fourth antennal segments of ♂
3. Fifth antennal segment of ♂
4. Sixth antennal segment of ♂
5. Seventh antennal segment of ♂
6. Eighth antennal segment of ♂
7. Ninth antennal segment of ♂
8. Tenth antennal segment of ♂
9. Eleventh antennal segment of ♂
10. Twelfth antennal segment of ♂
11. Penultimate segment of ♂
12. Terminal antennal segment of ♂
13. Palpus of ♂

sixth segment (Fig. 4) somewhat similar to the fifth ; seventh segment (Fig. 5) slightly shorter and slender than the sixth, basal enlargement a little over one-third the length of the segment and nearly five-eighths as long as thick, basal stem nearly one-half the length of the basal enlargement and as long as thick, apical enlargement one-fourth the length of the segment and four-fifths as long as thick, apical

stem twice the basal stem and a little less than the apical enlargement, nearly two and two-fifths as long as thick ; eighth segment (Fig. 6) a little longer than the seventh and shorter than the sixth segment, basal enlargement a little more than one-third the length of the segment and four-fifths as long as thick, basal stem a little more than one-half the length of basal enlargement and as long as thick, apical enlargement nearly globose, a little shorter than the width and one-third of the length of the segment, apical stem as long as basal enlargement and a little less than the apical enlargement, two-and-two-third times as long as thick; tenth segment (Fig. 8) equal to the seventh segment but slightly slender, apical stem three times as long as thick ; eleventh segment (Fig. 9) similar to the tenth segment but slightly slender ; twelfth segment (Fig. 10) shorter than the eleventh, basal stem twice as long as thick, apical enlargement a little longer than the basal and equal to the apical stem, wider than long ; penultimate segment (Fig. 11) shorter than the twelfth, basal enlargement a little less than one-fourth the length of the segment and five-sixth times as long as thick, basal stem more than twice its own thickness, apical enlargement similar to the basal, apical stem a little more than one-third the length of the segment and longer than the apical enlargement, four times as long as thick ; terminal segment (Fig. 12) shortest of all, basal enlargement nearly globose, a little less than one-third the length of the segment, basal stem half the length of the enlargement and one-and-two-third as long as thick, apical enlargement as long as basal and globose, apical lobe as long as broad and one-fifth the length of apical enlargement. **Thorax** : *Mesonotum* and scutellum blackish brown, postscutellum a little lighter. *Halteres* palish. *Wing* (Fig. 14) hyaline, two-and-one-eighth times as long as broad, three longitudinal veins, costa evenly thickened and interrupted at its union with vein R_5, vein R_1 uniting the costa at the middle of the wing, vein R_5 thicker basally, slighly curved distally and joining the costa well beyond the wing apex, vein *Cu* forked, vein R_s absent. *Legs* long, light brown, sparsely hairly, metatarsus shorter than the second tarsal segment and as long as terminal tarsal segment and a little over one-sixth the length of the second segment, second segment longest of all, longer than the rest of segments combined, third segment more than half the length of the second segment, fourth segment three-fifth the third segment. *Claw* (Fig. 15) yellowish-brown, long, slender, bifid, bent at right angle, empodium as long as the claw. **Abdomen** yellowish-brown. *Genitalia* (Fig. 16) basal clasp segment stout, enlarged basally, a little more than thrice as long as thick, terminal clasp segment half the length of the basal clasp segment, six-and-a-half times as long as thick in the middle, evenely curved, tapering towards the apex, ending in a blunt dark brown tooth, dorsal plate a little over one-third the length of basal clasp segment, broadly and abtusely incised in the middle, lobes rounded with smooth margines, sparsely setose, ventral plate longer and much narrower than the dorsal plate, nearly three times as long as broad, not broadened basally, deeply and broadly incised in the middle, lobes pointed, style slender, shorter than the basal clasp segment, little longer than the terminal clasp segment and a little more than nine times as long as thick.

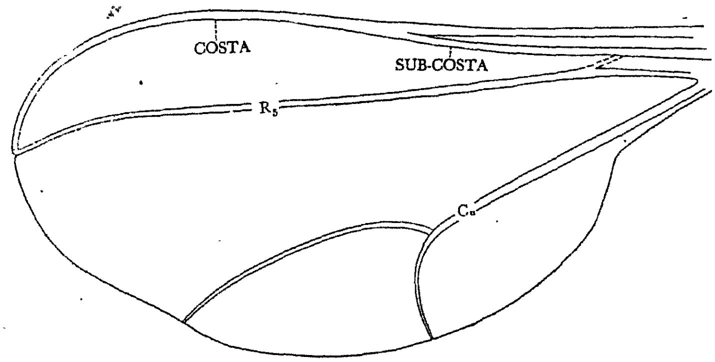
Holotype :

One male dissected and mounted on slide, labelled, "Mango leaf", reared from the leaves of mango tree, Tagore Town, Allahabad, P. G. coll dated 23–2–1961.

Paratype :

Some males on slides and some in spirit ; in the collection of the author.

Female : *Body* 2·3 mm. long, pale-brown. **Head.** *Eyes* confluent above. *Trophi* normal. *Palpi* tri-articulate (Fig. 25), short, light brown sparsely setose : first segment short, wider subapically, subglobse, second segment one-and-two-third times longer than the first, oval, nearly one-and-a-half times as long as thick ; third segment longest of all, slender ; length two-and-a-half times



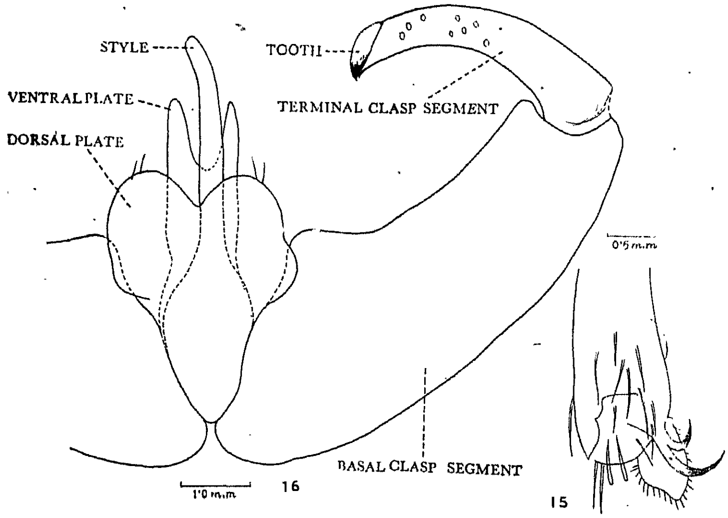
14

Text-figure 14. Wing of ♂

of its own thickness, wider medially. *Anntena* light brown, with 14 segments, cylindrical, stemmed, with two whorls of long setae and short circumfila ; scape (Fig. 17) nearly rectangular, light-brown, wider apically, short, width at apex nearly one-fourth of the length ; pedicel (Fig. 17) darker and shorter than the scape, subglobose, a little wider than long ; third segment (Fig. 17) fused with and longer than the fourth, nearly one-and-a-half times longer than the scape, with a small basal stem which is one-eighth the length of the segment and three-fifths as long as thick, enlargement four-fifth the length of the segment and-one and-two third times as long as thick, apical stem one tenth the length of the enlargement and three times as wide as long ; fourth segment (Fig. 17) enlargement a little less than the length of the segment and one-and-two-third times as long as thick, stem one-tenth of the enlargement and one eleventh of the segment, a little over three times as long as thick ; fifth segment (Fig. 18) a little less than the fourth, enlargement four-fifth the length of the segment and one-and-one-third of its own thickness, stem one-fourth the length of the segments and two-third as long as thick ; sixth segment (Fig. 18) a little shorter than the fifth, enlargement similar to that of the latter, stem nearly one-fifth the length of the enlargement and half the thickness ; seventh, eighth and ninth segments similar to the sixth (Fig. 18, 19, 20) ; tenth segment (Fig. 20) equal to the fifth segment, and a little shorter than the ninth, stem one-fourth the length of the segment four-fifth times as long as thick ; eleventh and twelfth segments similar to the tenth (Fig. 21) ; stem as long as thick, penultimate segment (Fig. 22) similar to the twelfth segment ; terminal segment (Fig. 23) slightly shorter than the penultimate and with apical knob, enlargement five-seventh of the segment and one-and-two-third times as long as thick, terminal knob a little over one-third the length of segment, subglobose, wider than long. **Thorax** as in the male ; *Wing, legs* and **Abdomn** as in the male. *Ovipositor* (Fig. 27) short, yellowish-brown, slightly exserted, finely setose, terminal lobes ovally rounded.

Holotype :

This species resembles *A. keshopurensis*, but is easily distinguishable by the following characters : large size of the body, proportion of the palpal segments,



Text figures 15 and 16 showing hind claw of ♂ and genitalia.

15. Hind claw of ♂ 16. Genitalia.

third palpal segment shorter than the second in male ; antenna twice the length of the body, third antennal segment longer than the fourth, circumfila loops longer than the stems ; wing two-and-one-eight times as long as broad, proportion of the leg segments and also in the structure of the genitalia and ovipositor.

KEY TO THE SPECIES

1. Antenna longer than the body............................2.

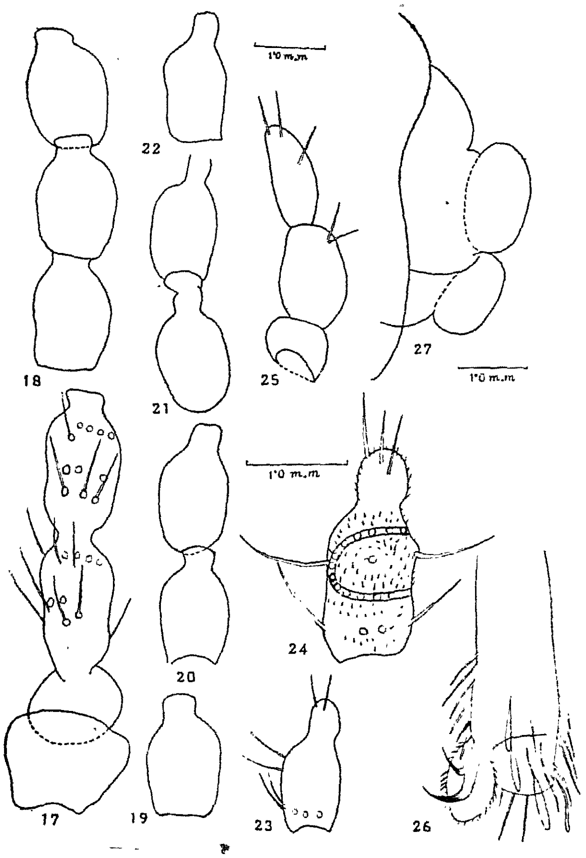
   Antenna shorter than the body............. ....3.

2. Third palpal segment in ♂ equal to the second ; lobes of the dorsal plate rounded apically ; ventral plate abruptly broadened basally ; terminal lobes of the ovipositor small and circular...*A. brunnigallicola* Rao

   Third palpal segment in ♂ one and half times the second ; lobes of the dorsal plate bluntly pointed apically ; ventral plate normal ; terminal lobes of ovipositor oval...... . ... *A. keshopurensis* Rao

   Third palpal segment shorter than the second in ♂ ; lobes of the dorsal plate rounded abtusely, ventral plate slightly narrow in the middle, broadly and deeply incised in the middle ; terminal lobes of the ovipositor ovally rounded.. *A. allahabadensis* sp.nov

Third palpal segment in the female nearly twice the second, in the male about one-and-one-fifth to slightly less than twice the second ; empodium longer than claw........................*A. echinogallipeida*



Text-figures 17 to 27 showing morphological characteristics of the female *Amradiplosis allahabadensis*.

17. Scape, pedicel, third and fourth antennal segments of ♀
18. Fifth, sixth and seventh antennal segment of ♀
19. Eighth antennal segment of ♀
20. Ninth and tenth antennal segments of ♀
21. Eleventh and twelfth antennal segments of ♀
22. Penultimate segment of ♀
23. Terminal antennal segment of ♀
24. Terminal antennal segment of ♀ enlarged
25. Palpus of ♀
26. Hind claw of ♀
27. Ovipositor.

3. Antenna half the length of the body, claw slightly curved ; empodium equal to the claw ; lobes of the dorsal plate slightly emarginate at the sides ; apically fringed with short stiff setae ; ventral plate not abruptly broadened at the base..*A. viridiballicola* Rao

Antenna less than half the length of the body ; claws bent at right angles ; empodium much shorter than the claw ; apical margin of the dorsal plate conspicuously fringed with short stiff setae arising from tubercle-like structures ; ventral plate abruptly broadened at the base......*A. amreamyia* Rao

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